SPINAL CURVATURE

HEATHER BIGG

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THE following is the series of works in course of preparation by the Author which will deal with all the various deformities of the body that are amenable to mechanical treatment:

I. ON CURVATURE OF THE SPINE, including its Origin, Classification, and Mechanical Treatment.

II. ON DEFORMITIES AND DEFICIENCIES OF THE TRUNK, including Hernia, Prolapse, Displacements of the Uterus, &c.

III. ON DEFORMITIES OF THE HIP-, KNEE-, AND ANKLE-JOINTS, Paralysis of the Muscles of the Legs, Clubfoot, and Deformities of the Toes.

IV. ON DEFORMITIES OF THE HEAD AND UPPER LIMBS, including Wry-neck, Deformities of the Shoulder-, Elbow-, and Wrist-joints, Paralysis of the Muscles of the Arms, &c.

V. ON ARTIFICIAL LIMBS, Substitutes after Amputation, and other Prothetic Appliances.

SPINAL CURVATURE

COMPRISING

A DESCRIPTION OF THE VARIOUS TYPES OF CURVATURE OF THE SPINE

WITH

THE MECHANICAL APPLIANCES BEST SUITED FOR THEIR TREATMENT

BY

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ILLUSTRATED BY THE AUTHOR WITH NUMEROUS PEN-AND-INK DRAWINGS

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PREFACE

THE object of this book is to convey to the Medical Profession in as clear a way as possible an idea of the mechanisms which are constructed and are best suited to the cases of Spinal Curvature which come under their care, and to put these before them in such a simple and sequential manner that they may be able instantly, by turning to these pages, to select the apparatus that is best adapted to the requirements of their patients.

To this end the work is divided into three chapters. The first is restricted to the consideration of some points and principles in the construction of the human body which have, perhaps, up till the present time not been fully appreciated, and terminates with a very simple and natural classification of spinal curvatures based on such considerations. The second chapter comprises a detailed description of the various spinal curvatures in accordance with the foregoing classification, and with each is described the instrument or appliance theoretically indicated as most useful, and whose utility has been substantiated by actual practical experience. The third chapter is dedicated to the consideration of Professor Sayre's suspensory-plaster method, and to

pointing out the fallacies of its employment as a universal treatment for spinal curvature.

The Author, in undertaking this work, has kept as nearly as possible to the mechanical phases of spinal curvature; but he feels that the fact that in order to secure its completeness he devoted, on the one hand, five years to the ordinary curriculum of study at a London Hospital, and subsequently, on the other hand, five years to personally acquiring, even down to the most trivial details, all the operative and manipulative processes in the construction of orthopædic mechanisms, will be a sufficient guarantee that he has used his best endeavours to bring all the practical facts he could collect, both in mechanical and medical science, to bear on the subject.

56, WIMPOLE STREET,
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SPINAL CURVATURE

CHAPTER I

PRELIMINARY PRINCIPLES

Preliminary principles.—In order to arrive at a correct idea of how spinal curvature really arises, and in order to make a classification of curvatures which will clearly and simply accord with the mechanisms necessary for treatment, certain preliminary principles must be understood.

Gravital centre and its maintenance.—In all the higher animals, and in man among them, there is found in developing from their earliest stage to the adult period a constant disposition to range evenly the various parts around a certain point which is most suitably disposed to the organs of locomotion, and which point is the gravital centre of the body. This disposition around a centre is not confined to animals. Crystals of the same kind, for example, whether small or great, are always identical in shape, and, commencing minutely at a point, become by even additions bigger and bigger in an exact relation to that point. The natural body of an animal also increases in a definite relation to *its* point, and this point or gravital centre is invariably situated in such a position that it may best be under the control of the organs of progression, whether these be legs, or wings, or fins.

Now, a crystal once set is motionless throughout. The reverse is the case with an animal, for its members are perpetually shifting their relative positions

with respect to each other, and of course with these changes the centre of gravity shifts in proportion. This necessitates some arrangement for constantly bringing the errant centre of gravity back to its proper position, a position which is named the gravital point. So that an animal is structurally speaking a machine, a portion of whose mechanism is devoted to keeping the body in such a position, and its weight at such a point, that the whole may most easily be placed in movement by another portion of the mechanism, namely, the organs of locomotion.

In Man, from his biped mode of progression, this is more apparent; the naturally normal position of the gravital centre, and the active and symmetrical perfection of the human body, being co-existent and relatively dependent. Round this centre are exactly reared and correctly balanced the elements of the frame in a manner best suited to the alternating motions in walking or running; and it is to the effort of retaining this centre in its proper and aptest position that the Spine, with its numerous peculiarities of skeletal structure and muscular distribution, is dedicated.

Functions of the Spine.—Nature preserves in her doings the strictest economy, and with this view seldom permits any organ to bear the burden of a single function only. The Spine offers no exception to this rule. It serves as a tubular protection to the great nervous mainway of telegraphic communication existent through the body, it acts as a scaffolding on which are built the larger vital cavities, it permits a bodily pliancy conformable with the more extravagant actions of life, but all these uses that it has are secondary compared with its pre-eminent and primary function of so regulating the relative position of the upper and lower extremes of the body that the *status quo* of the gravital centre may be in accordance with the principles above enunciated.

The mechanical structure of the Spine.—In discharging this duty, the spine will, just as in the case of any other piece of motor mechanism, be composed of two distinct parts. On the one hand there will be the motor agent, which will include the generation and government of the force in use; this constitutes the musculo-nervous portion of the spine. On the other hand there will be the structural scheme, by which such force is adapted and converted to fulfil its purpose; this constitutes the osseo-ligamentous portion of the spine.

Osseo-ligamentous part of the Spine.—The spinal column is composed of a number of mathematically moulded and superimposed osseous segments called vertebræ, between which there is a sufficiency of motion to permit the column to bend in accordance with the necessities of life. These segments are combined and stayed against irregular or excessive movement by ligaments or cords, which for the most part are inextensible. The column, formed of these segments and stayed by these ligaments, is curved in such a manner as to give the greatest and speediest facility for relative alterations of the position of the parts in its length. The nature of its curves is probably further determined by the exigencies of muscular disposition, motion, as the earliest function to appear in the simpler animals, being that for which most is structurally sacrificed in the higher.

Musculo-nervous part of the Spine.—The inert and passive parts of the column, to become active and efficient for the spinal function of regulating the position of the body's gravital centre, need as much the adjunct of some controllable motor power as the wheeled works of a watch require a spring to propel them, and a fly-wheel to order the rhythm of their rate, for what the one possesses to be an accurate time-keeper, the other must have to be an accurate balance-keeper.

With this view the spine is clothed with multitudinous and complicated muscles, which control or cause the movements of its segments, and these movements it must be stated are never abrupt nor angular in kind, but always smooth and undulatory.

Muscle exerts its power in obedience, using a metaphor, to the telegraphic calls it receives from certain head-centres, akin to district telegraph offices. The same set of muscles may, pursuing the simile, have wires laid down so as to be in communication with several of these centres. The spinal muscles are under the control of two head-centres of this kind; that of the Will and that of a balancing Regulator.

Obedience to voluntary impulses, or the Will, is evinced in many ordinary actions, as bending or twisting the body, stooping, or bowing, which are intentionally and consciously made.

The balancing or gravital Regulator under which the spinal muscles ordinarily act is very different, and governs them spontaneously, irrespective of volition or consciousness. Its duty is to stimulate the spinal muscles in such an even manner that the forces these latter evolve shall constantly be the correct ones to keep the centre of gravity of the body at its proper point, and cause it to resume that position should any unforeseen circumstance change it. The movements of the spine in answer to this Regulator are undulatory, and it is further probable that every effort performed in obedience to it is effected by a double wave or curve of motion, each wave travelling along the spine in a direction opposite to the other. This duplex character of spinal action foreshadows and explains the same of spinal curvature.

From what has preceded, the spine as a whole may be described in a kind of "house-that-Jack-built" sequence, as consisting of a Regulator that sends balancing impulses along the nerves to the

muscles, that generate a correct force, that is converted and adapted by the bones and ligaments to fulfil the gravital aim of the entire combination. And, further, the natural division of this said combination into musculo-nervous and osseo-ligamentous parts is of the greatest consequence in considering the origin of spinal curvature.

The body an erected structure.—All bodies under the influence of gravity maintain their ordinary position in one of two manners; speaking simply, they stand or they hang. The table in a room does the former—the chandelier the latter.

The properties of matter respectively called into play in these two instances differ radically the one from the other. A body stands in virtue of its inherent rigidity, hangs by its coherent tenacity. Most ordinary substances possess both these qualities in greater or less degree, in which case their matter may be so structurally disposed as to favour the exhibition of one attribute rather than the other. For instance, steel forged as links to form a chain is contrived for suspension; cast as a cylinder, is suited to prop an erection. Hence, in humanly-devised machinery material and the disposition of that material are varied accordingly as the part under construction is to be pendant or erected.

In machines devised and constructed by nature—for animal and plants are machines—the same rule holds, but with greater perfection, inasmuch as nature's mode of building, which we term growth, is more subtily exact. This being so, in pulling any of her machines to pieces, as a watchmaker would a watch, there is found a most perfect relation existent between the material and construction of any part and the duty that part may have to perform.

For example, in the human body the arm is palpably pendant under ordinary circumstances, and an examination into the minute details of its parts brings to light a structure in strict conformity with

the exigencies of that condition. Again, the lower limb, in walking, is at one time bearing the entire weight of the body as the leading leg, at another time swinging forward as the following leg. Its intimate arrangement displays a double scheme of structure, rendered necessary by this double duty, as is easily seen in the ligamentous complexities of the knee and its other joints.

It is by reversing the logical process that function or purpose can be easily ascertained on the ground of investigated structure; and if a mathematical examination of the build of the body be made, it will be found and can be absolutely asserted that the human frame, as a whole generally, and the spine in particular, are erected from below, piece by piece, in as mathematically precise a way as a house is by square and plumbline, each segment being balanced and propped on the one below with equal truth, from the sole of the foot to the crown of the head. The value of this assertion will become more manifest when, later on, the influence of suspension on the body is considered.

Maintenance of shape of body.—The whole body consists (just as has been described in the case of the spine more particularly) of an osseo-ligamentous skeleton clothed with the musculo-nervous parts which give this skeleton stability and mobility. It is by the mathematical examination of the osseo-ligamentous skeleton that the assertion that the entire body is an erection is arrived at; still the skeleton alone is not a *stable* erection, seeing that a dead man cannot stand. It is to the truth and evenness of the musculo-nervous elements of the body (in obedience to the gravital regulator before mentioned) that the stable maintenance of erectness and shape in a healthy body is especially due. And loss of shape or deformity will arise from one of two causes: first from any perversion in the evenness and balance of the musculo-nervous powers, on

which the stability of the skeleton depends, paralysis or spasm as causes of deformity being instances of this; and next from loss of truth in the construction of the skeleton itself, the shortening of the leg in hip disease being an example of this, in which case the attempt of the body to rear itself on the uneven base which arises from such mischief brings about deformity. This latter cause leads to a principle which is of the greatest importance in the consideration of the maintenance of the shape of the spine or of the body.

Restituence is that tendency in virtue of which the spine, or any part of it, persists in assuming certain definite curves in accordance with its surroundings, these surroundings being, as will presently be shown, the base on which it rests, and the burden it has to bear. The whole body from the sole of the feet upwards is subject to this restituent tendency, but the spine, which is only part of the body, is taken as better and more simply to exemplify it. The natural curves of a healthy spine are the restituent curves of its natural surroundings, which are a level base below and a symmetrical burden above. As long as these conditions are true and natural so long will the curves of the healthy spine remain natural; but the moment that anything unnatural arises in the surroundings, and that either the base below or the burden above becomes irregular, then immediately a new series of restituent curves will commence to form, and these being unnatural are recognised as deformities. And so for every unnatural surrounding of the spine there is an ideal unnatural curve which restituence dictates and which the spine tends persistently to assume. Thus, all the curves of the healthy spine, whether natural or unnatural, are but restituent curves of similar surrounding. It was previously stated that the natural spinal curves were traceable in structure to the exigencies of motion, and this is true develop-

mentally; it is none the less true, however, that their maintenance is due to the restituent tendency described. Nature provides for construction on a certain plan in one way, for its continuance and integrity in another.

The refinement to which this principle of restituence is carried is proved by the constant existence in the natural spine of a slight curve, with its convexity to the right in the dorsal region, when the right arm is more muscular and consequently heavier than the left. Bichat ascribed this curve to the muscularity of the entire right side generally, and Cruveilhier to the position of the aorta, but the author believes he is correct in saying that restituence is the cause, the burden of the spine being slightly weightier on the right side in such cases. While restituence is inherent through the body as a whole, governing the relationship of all its pieces as they are erected and balanced one above the other from the sole of the foot to the crown of the head, it also exists as the governor of the smallest movable portion of the body, as, for example, between a couple of vertebræ..

Relations of the Spine.—The relations or surroundings of the spine are most important: not only because, as has just been stated, it is to their correctness that the healthy spine owes its own correctness, but also because in turn if the spine becomes unhealthy and deformed through disease in itself, then the shape of its surroundings is disturbed, whilst various vital organs which owe their health to the undisturbed shape of the cavities which contain them have their functions impaired, and ailments consequent on this arise. So that the spine and its surroundings are mutually interdependent for form one on the other.

The body is obviously divisible into the legs, the head, and the trunk, to which latter the arms are appended. The head and the trunk may practically

be considered as one, and their central bony structures be accepted mechanically as constituting the spine, the head being the extreme segment at the upper, the sacrum the same at the lower end. In the intermediary length lie the arrangements for motion devoted to fulfilling the spinal function in the manner already enunciated. (Fig. 1.)

The sacrum or lowest brick, so to speak, of the spine forms the keystone of an arch of which itself, the hip-, thigh-, and leg-bone are factors. This arch, in its turn, rests on the arches of the two feet, so that a triplet of arches is formed, which, if not in strict accordance with the conventional ideas of masonry, are, nevertheless, in the erect and upright position of the body, of perfect architectural truth.

To their truth the spine is indebted for a level base on which it may best be posed to perform its gravital duties; while departure from correctness deranges the entire harmony of the combination, and predisposes irregularities on the part of the spine itself.

While, on the one hand, the spine is thus dependent on three arches for its erectness, it, in its turn, is in intimate relation with three cavities, whose normal shape is in great measure governed by and consequent on the integrity of its shape. These cavities are the abdomen, chest, and nervous-centre-case, and contain the various vital organs, the performance of whose functions in the aggregate constitute the act of life; if working well, of healthy life; if ill, initiating disease; and if ceasing, determining death. They are the wheels of the clock-work of existence, which must all move rightly and in unison that the time should be healthily passed. These vital organs are packed in their boxes with greater or less exactitude, having the precise amount and form and room assigned to them that the exigencies of their work demands, which work is properly performed only when such is the case.

The three protective cases vary in mobility and strength in accordance with the delicacy and importance of their contents, which may be reviewed as follows:

The nervous centres—that is, the brain and spinal cord—are situated respectively in the cavity of the skull and the spinal canal, the whole constituting the nervous-centre case. Their position there, as being nearest the centres of motion, is least liable to change, this fact, together with the strength of their bony clothing, being rendered necessary by the fragility of their structure. The brain, which is the bodily seat of government, is, in its protected position, uninfluenced actually by spinal movements; but the spinal cord, which proceeds from it and through the spinal canal, in which it is loosely packed, forms the mainway of the telegraphic communication which pervades the body, and is affected by all alterations of the spine. So long, however, as the spinal movements are restricted within natural bounds, so long the mainway is intact; but should these restrictions be, through disease, accident, or otherwise, removed, then, there being no provision for the emergency, the mainway becomes nipped and its function impaired, or even entirely interrupted, with as much perfection as electric communication is by section of the wire.

The chest is less sturdy in structure than the nervous cavity, and more pliant and elastic in constitution, as befitting the nature of the heart and lungs which lie within. Its walls have to rely on the ribs for the kind and constancy of their shape, and as these last are not mere appendages, but almost actually part and parcel of the segments of the spine before referred to, the consequences to the chest of abnormality of the said segments is self-evident. The contained organs will, however, submit to considerably more comparative topical disturbance than the nervous centres would, with-

out detriment to their duly discharging their duties.

This licensed mobility is still further marked in the abdomen, where the organs, namely, stomach, liver, spleen, intestines, urinary and genital viscera, hang in apparent confusion from the bony scaffolding behind and above, and will undergo unusual rudeness and roughness of motion without injury, or suffer only transitory inconvenience. Now, this seeming mesenteric medley is apparent only, and not actual; for as long as the staying ligaments and osseous scaffolding are normal, the viscera move only within strictly prescribed limits, and as each keeps its own range, it is unable harmfully to impair the vitality of the others. But if the spine which forms the scaffolding becomes so altered that the slackened ligaments fail to sustain their organs, these last interfere with each other frequently to their extreme detriment, and becoming dislocated or malflexed are liable to severe functional disturbance.

To this displacement and disturbance of the organs within the three vital cavities of the body are due what will be later described as the *secondary results* of spinal curvature.

There remains of the bodily members only the arms for consideration in their relation to the spine. These limbs are mere dependencies of the frame, outstanding detachments, as it were, whose influence would be marked rather by their absence than aught else, loss of an arm deranging the evenness of weight disposed on each side of the body.

Spinal Curvature and its classification.—The term "Spinal Curvature" has been conventionally applied to denote an unnatural state of curvature of the spine. In the ordinary and natural condition the spine exhibits the well-known curves which constitute the arch of the neck, the round of the back, and the small of the loins. In unnatural conditions

these become obliterated, exaggerated, or confused by other novel curves, in which case symmetry, and that mechanical perfection of which symmetry is but the outward expression, both disappear.

From what has been previously stated, a classification of the different kinds of spinal curvature in *strict accordance with their mechanical origins* can now be arrived at, which classification, although different from that usually in vogue, the author believes to be clearer and more comprehensive. Spinal curvature has, for example, been classified by the region of its occurrence, as being cervical, dorsal, lumbar, sacral, and so on, and this mode of —to use an analogy—determining kinds by countries is obviously illogical and artificial. The directional manner of classing curvature is none the less so, seeing that distinctions into antero-posterior, lateral, and rotatory, are based on results, not on causes. Finally, a constitutional classification fails to include all curvatures, some, as will be shown, being brought about without the slightest constitutional disturbance.

Now, the classification which is based on the mechanical origin of spinal curvature, rests on a *résumé* of what has been previously stated in this chapter, and a first broad division of curvatures into those of *intrinsic* and those of *extrinsic* origin can be made.

For the natural body has been shown to be a mathematically erected structure, with a triplet of arches formed by the legs and feet below, which triplet acts as a base for the spine; and the *spine* in

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FIG. 1 is a diagram intended to show the mechanical structure of the body, and especially the relationship of the spine (*a*) to its base of arches below (*c*), and to its burden (*b*) above. The three arches are, as will be seen, the two arches of the feet, and the arch formed by the legs and pelvis, the keystone of which latter arch is the sacrum. The burden is constituted by the head, chest, and arms. In the truly-formed body both base and burden are in bilateral symmetrical relationship to the spine.

FIG. 1.

its turn bears, as its *burden*, the upper mass of the body, comprising head, arms, and trunk, which said mass in the natural and healthy condition is evenly disposed, bilaterally balanced, and symmetrical around the spine both in weight and form.

Now, these three factors, *base* below, *spine*, and *burden* above, form together the integral whole of the body, and are kept in their proper positions one above the other by muscles obeying the gravital law whose exhibition is termed *Restituence*. These three factors, *base*, *spine*, and *burden*, are relatively reliant on each other for their true position one above the other, and if anything directly affects the truth of one of these factors, it will indirectly affect the truth of the others. It follows, then, that spinal untruth (using the word untruth as mechanical untruth, and synonymous with deformity) can be of intrinsic origin, and arise from alteration of the *spine* itself by its getting out of gear, as a piece of mechanism; or that, while the spine is mechanically perfect and healthy, the other factors, *base* below it, or *burden* above it, may become untrue, and so react and cause untruth or deformity of the spine itself, in which case the deformity is of extrinsic origin.

I. **Curvature of intrinsic origin** is wholly independent of abnormality in the circumstances of the spine. The base below and the burden above are, to begin with, pefectly natural, and if they become deformed do so as result and not as cause. It is the column itself that errs. Now, the spinal column as a machine, was shown to consist of two parts, the musculo-nervous, dedicated to the generation of force, and the osseo-ligamentous, devoted to the conversion and adaptation of that force to its uses. Each of these parts is liable to accidental and constitutional derangements, under which each is productive of a curvature varying vastly from the other in character and course of progress. So that intrinsic

curvature subdivides into two kinds in accordance with this distinction.

The musculo-nervous constituent generates the force necessary for the performance of the gravital function of the spine. The ultimate elements of this musculo-nervous system are, in a natural state, all of even power. In ill-health, however, these ultimate powers become irregular. A disturbance in the regular relations of the musculo-nervous elements of a part under voluntary control, as of an arm or a leg, must be of tolerable magnitude before its results can appear as deformity, for, the will being a factor in the question, involuntary inability is countervailed by volition. But on an involuntary part, and the spine has been shown to be ordinarily under involuntary government, the influence of such disturbance is infinitely graver. So that, when from unnatural causes, a disparity is determined in the evenness of the power and action of the elements of the spinal musculo-nervous system, deformity ensues.

The direct or so-called primary deformity is usually restricted in region and curved in character; but it follows, in consequence of restituence, that the other healthy portions of the spine establish a secondary and complementary curve or curves, simultaneously with the formation of the primary one.

The *osseo-ligamentous* constituent forms the solid edifice of the spine, and adapts powers to purposes, as before shown. Its bony segments are, through disease, subject to degeneracy, by which their solidity disappears, in very much the same way that a piece of very hard and stale bread would, if soaked in water, while retaining its form lose its firmness. Under the influence of this disintegrating disease the segments of the spine become unable to sustain the superimposed weight, and give sharply away, as a wall whose lower bricks had rotted, and a deformity, generally angular, results. But few seg-

ments ordinarily are affected, and with a partiality dependent on the gravity of the attack; and these lie usually next each other in one locality, although occasionally the spine may suffer in more than a single spot. In the meantime the softening segments commence to fuse together. The ligaments may mechanically be considered as playing a passive and subservient part, although of course their integrity is influenced by the inflammatory processes at work.

Under ordinary and favorable circumstances a turning point comes; the disintegration ceases, the fused and softened bone substance rehardens, and fixes the deformity that may have occurred in a manner unfortunately and practically unchangeable. The clay, so to speak, sets and is unalterable. This consolidation by no means terminates the changes which take place in the spine, a point which up to the present has not been clearly pointed out, because the principles of restituence had not been pointed out. It is a fact, however, that the spine, provoked by an abrupt and unbending distortion in part of its course, tends to establish itself in a new line of restituent curves; and, as will be subsequently seen, the government of this second or restituent stage of osseo-ligamentous curvature requires as much care as the efforts that have to be made in the first stage do, to secure consolidation at the original seat of disease.

II. **Curvature of extrinsic origin** arises, as has been said, from irregularity or untruth of either the triplet of arches on which the spine rests as a *base* below, or of the mass which the spine bears as its *burden* above.

The elements of the three arches below are subject to irregularity from many causes, such as weakness at the insteps of the feet, deviation from truth of the relative axes of the ankle, knee, or hip, through accident, paralysis, contraction, or arrested development; disturbance of the stability of the pelvis

by anchylosis of the hip-joint; the spurious unevenness of assumed positions; loss of the lower limb and use of an ill-made artificial one, and so on.

On the other hand, the evenness of the burden above can be disturbed by such causes as loss of an arm, diminished development of an arm, or the constant carriage of a weighty body on one shoulder or side.

Any of these causes will originate spinal curvature, although the spine itself is perfectly sound and healthy, and only loses its shape by its restituent efforts to rearrange the body, under the provocation of the changes that have taken place in its circumstances.

Complicated Curvature.—There is no reason why two or three types of curvature, previously described, should not be coexistent, and why an unfortunate individual should not at one time be afflicted simultaneously with the causes of all three, the case being a knotty tangle of three threads as it were. To disengage the knots, however, each thread would separately have to be held in view, and so also each type of curvature would present its own bearings in the mechanical diagnosis of the case.

Infantile Curvature may be congenital or it may be acquired after birth, and before the child has learnt to walk; for the attainment of the power of walking may be looked upon as the line which mechanically demarcates between infantile curvature and the types previously described; because, when once the child walks, the body begins to be on a different mechanical footing to what it previously was.

There are cases, of course, of infantile curvature which may arise by malformation, through an oversight of nature in the construction of the infant; but these would be rare and extraneous cases, and the *rationale* of their production beyond the range of scientific ken. On the other hand, it appears not

altogether improbable that in the latest stages of pregnancy a child can acquire curvature by a departure from an originally perfect plan of construction, at all events, the fact that sometimes exceedingly young children are found suffering from it seems to warrant this conclusion. Infantile curvature, however, on the whole is rare, and its peculiarities, from the point of view of its treatment, lie rather in the fact that the bodily tissues are less developed, the bony surfaces incomplete, and that the consideration of the spine is simpler, because it has not fully acquired the functions which devolve on it when walking commences.

Secondary results of Spinal Curvature.—Spinal curvature is usually regarded as serious rather from the deformity which accompanies it than from the functional disorders which very frequently arise from it. It has been already pointed out that as the spine lapses from its natural form into deformity, so the three protective and guardian cases of the vital organs (the abdomen, thorax, and skull, with the spinal canal) become changed and cramped, and that the organs themselves become dislocated, compressed, and subsequently disordered. As a consequence, many organic ailments may be the offspring simply of spinal curvature, and the treatment of these ailments will be similar to, and simultaneous with, the treatment of the curvature to which they owe their origin.

Course of Spinal Curvature.—Diseases considered in regard to their course fall into two kinds. In one kind the disease must run its course from beginning to end, and art has rather to safely aid this passage than interfere with it. In contradistinction to this kind, some diseases have a course which can be accurately mapped out, from the most trivial commencement to the most grave termination, but along the whole of which a sufferer very rarely has to pass, and the efforts of art are directed

towards checking the passage as speedily as possible. To this latter kind belongs spinal curvature. There is for each sort of curvature a definite career and series of stages, traversed only in its entirety by the very worst and most neglected cases, seeing that it lies within the reach of human power and skill to cut the disease short at almost any stage, and even at the outset to avert it altogether. Consequently, when the stages of the various kinds of curvature come to be described in the ensuing chapter, it must be understood that they constitute rather a map of what may be than of what need be.

Treatment of Spinal Curvature.—In spinal curvature, as the spine lapses from its natural condition, two evils arise. The one is bodily deformity which is recognised visibly; and the other, as a secondary result, is that functional disturbance of vital organs which is due to derangement of their position, by the alteration in shape of the cavities which contain them. The first end and aim in the treatment of spinal curvature is to begin by checking further lapse into deformity, a point that can nearly always be attained. The next point is to attempt actively to make the spine retrace, as it were, the steps of its previous lapse, and to restore it to its correct and original position; and this, in the early stages of curvature, is generally possible, the body being restored to its natural form and the organs to their true position. When, however, such restoration is impossible, as it unfortunately is in the later stages of curvature, then, after the progress of the curvature has been checked, all efforts must be made to bring the body into as reasonable a shape as possible that the most obvious features of deformity may be removed, and at the same time to increase if necessary the capacity of such vital cavities as the thorax and abdomen, that their contained organs may enjoy greater freedom, and not be functionally interfered with through compression or dislocation.

Mechanical Appliances.—The origin and progress of spinal curvature is purely a mechanical question; and its treatment consequently is the same, nor has it ever been otherwise regarded. The body is like an erected edifice which begins to give way, and must be managed as such. When a house is giving way, it is first shored up to check further lapse from truth, and then the walls are, if needs be, restored by properly directed forces to their correct position, and the house to original uprightness, while all weak points are properly strengthened. So it is with the human frame; proper mechanical means have to be adopted to remedy defects which originate mechanically. Mechanical means, when applied to the human frame, must, in order to have continued action, be carried about on the body itself, or, in other words, be so arranged that they may be *worn* by the body. A piece of mechanism so worn is known by the name of a mechanical appliance.

Now, the mechanical appliances for the treatment of spinal curvature have to be constructed with a definite and different aim for each stage and each kind of curvature, and the truest conception of what they have to do, and how they are best made to do it, is formed by obtaining the clearest idea of the cause and origin of the curvature which it is the duty of the appliance to check, correct, or control. Hence the value of classifying curvature by its origin, as the author has done, in lieu of by any other method.

In the next chapter each particular mechanical appliance for spinal curvature will be carefully described; it will suffice here to state one or two points about mechanical appliances in general.

All mechanical appliances are passive or active. The *passive* impart through a diffused hold their own properties to the parts to which they are applied. They exercise no definite motor force.

An excellent example of a passive appliance is a splint moulded of leather or plaster, or any other similar substance; it gives quiescence to the parts to which it is adapted, and with the greatest generality and spread of hold combines the absolute minimum of actively exerted power; the intrinsic immobility of the splint resisting the instability of the parts so protected. The *active* mechanical appliances, on the other hand, are constructed with the express purpose of exercising some definite moter force. They do not take a very diffused hold of the parts to which they are applied; and there is always embodied in their construction some active agent exercising some power, such as elastic power, spring power, or rack power. It is obvious, therefore, that where absolute quiescence is not aimed at, and where, on the contrary, alteration of form is desired (as it is in most cases of spinal curvature), an active mechanical appliance is the correct one to adopt. This point cannot be too strongly insisted on, as it has lately been urged that all types and forms of curvature can be treated by that most passive of all passive appliances, a splint; whereas the author will prove later on that it is only one stage of one particular type of spinal curvature that can be asserted always to require a passive splint-like appliance for its treatment.

In all active mechanical appliances, steel is largely used; and wisely so, because of the multiplicity of its qualities. Its capability of varying its nature according to the temper it is given, the ease with which it can be moulded while soft, the firmness it can be made to acquire when hardened, the unparalleled combination of lightness and strength it will afford; all these point to steel as the material best suited for the construction of mechanical appliances, and it can be used in strips so thin and slender as to be wholly invisible through the clothing, when fitted to the body. While these points were

in the past entirely unappreciated, mechanical appliances were most usually cumbrous, clumsy, and uncomfortable; those of the present need never be so. Steel was ordinarily associated in the mind with the massive machinery and gigantic girders of engineering. Its very mention was wont to convey an idea of cold, crude, resistless force, and this association has founded a prejudice, which has made people shrink from the idea of "wearing steels," and of forfeiting their freedom in what might seem a mediæval manner. This idea, however, has now been by the refinements of science exploded; it was a popular prejudice, and, like many other popular prejudices, entirely fallacious.

CHAPTER II

VARIETIES AND TREATMENT OF SPINAL CURVATURE

Programme.—In order that the divisions into which the substance of the ensuing chapter naturally drops may be more clearly shown and the better appreciated the adjoining programme has been inserted. It will serve as a plan at the outset of the chapter, as a guide during its progress, and will be found finally to be a condensed summary of its contents. It is trusted that in this manner confusion may be avoided, and that distinctions may be marked rather by reference to the programme than by differences which would have to be made by the type in printing.

SECTION I.—Intrinsic Curvature

The body has been shown to be divisible into the spine, its base below, and its burden above. In pure intrinsic curvature both the base and the burden of the spine are quite natural and true, and if, as spinal deformity progresses, they suffer alteration, it is as the result not as the cause. It is in the spine itself that the evil originates, and that deformity begins. It has been also shown that the spine is constituted of two distinct portions, the musculo-nervous and the osseo-ligamentous; according as one or the other of these portions is affected so will be the kind of curvature.

A. Musculo-nervous division of Intrinsic Curvature

The musculo-nervous element of the spine consists, as has been already pointed out, of three con-

Programme of the Types of Spinal Curvature.

Type.	Origin.	Treatment.
Section I.—Intrinsic Curvature ...	From error of the spine itself; the base and burden of the spine itself being true and natural	By correction of the spine itself only; the base and the burden of the spine being left untouched.
A. Musculo-nervous division	From error of the musculo-nervous elements of the spine itself	By active aid to the musculo-nervous elements of the spine.
1. General musculo-nervous curvature	From atonicity affecting all the musculo-nervous elements of the spine itself	By active aid to all the musculo-nervous elements of the spine.
a. First stage of gen. mus. curv.	From intermittent loss of the true spinal curves in an antero-posterior direction	By gymnastic exercise, or by the appliance for the next stage.
b. Second stage of gen. mus. curv.	From permanent loss of the true spinal curves in an antero-posterior direction	By an active appliance, antero-posterior in power and direction, to restore the true curves.
c. Third stage of gen. mus. curv.	From rotato-lateral lapse of the spine and ribs	By an active appliance rotato-lateral in power and direction.
d. Fourth stage of gen. mus. curv.	From accommodative absorption of the bony segments of the spine by mutual pressure, producing irregular lapse	By an active appliance adapted in power and direction to the lapse.
2. Particular musculo-nervous curvature	From atonicity or spasm affecting some particular musculo-nervous elements of the spine, and not all	By active aid only to the particular musculo-nervous elements of the spine that are overbalanced.
B. Osseo-ligamentous division.....	From error, through disease of some of the osseo-ligamentous elements of the spine itself	By controlling the results of disease of the osseo-ligamentous elements of the spine.
a. First stage of osseo-ligamentous curvature	From inflammation, softening, and yielding of the bony segments of the spine itself	By a passive splint affording rest to the diseased part from flexion, undulation, or strain.
b. Second stage of osseo-ligamentous curvature...	From the interposition in the course of the spine of a consolidated mass, whose plane of articulation are untrue	By an active appliance to govern the restituent changes provoked by the untrue consolidated mass.

SECTION II.—EXTRINSIC CURVATURE ...	From mechanical error of some part of the body other than the spine itself	By correction of the parts external to the spine and of the spine itself if necessary.
a. Base curvature	From error of the base on which the spine is reared	By correction of the base on which the spine is reared and of the spine itself if necessary.
b. Burden curvature	From error of the burden the spine bears	By correction of the burden the spine bears and of the spine itself if necessary.
SECTION III.—COMPLICATED CURVATURE	From simultaneous coincidence of two or more of the previous types of curvature	By treating separately each of the coincident types of curvature.
SECTION IV.—INFANTILE CURVATURE:		
a. Infantile malformity	From malformation *in utero*	By treatment specially according to the malformation.
b. Infantile deformity.....	From acquisition of curvature after birth and before attaining the power of walking	By treatment, according to the type, but more simply than in adult cases.
SECTION V.—SECONDARY RESULTS OF SPINAL CURVATURE:		
a. On nervous organs.....	From pressure on, or displacement of, nervous centres or spinal nerves	By removal of pressure and replacement of the nervous centres or spinal nerves.
b. On thoracic organs.....	From pressure on, or displacement of, the heart or lungs	By removal of pressure and replacement of the heart or lungs.
c. On abdominal organs	From pressure on, or displacement of, the abdominal or pelvic organs	By removal of pressure and replacement of the abdominal or pelvic organs.

stituents, namely, the nervous centres, the muscles, and the nerve-line of communication between the two. The action of this musculo-nervous combination is most simply expressed, however, by referring to the muscles alone as acting, and sinking for the moment the other elements of the musculo-nervous combination, just in the same manner as in speaking of a bell which really consists of a bell-handle, a bell-wire, and the bell itself, reference is made to the bell alone. The spinal muscles then clothe the spine, and if they act truly and uniformly, both maintain the shape of the spine and enable it to perform its balancing duties. The muscles, however, will only act truly if they are healthy and tonic. Now, there are certain impoverished or morbid states of a person's system which may affect *all* the muscles equally, and through the entire spine may render them unhealthy and unequal to the duties they have to perform. On the other hand, it often happens, from some local injury or lesion, that only *one or two* of the spinal muscles may become the subjects of impaired power, all the other muscles remaining healthy and intact. From these two different conditions two different kinds of deformity arise, the first, which may be styled the *general* type of musculo-nervous curvature, in which the entire set of spinal muscles are debilitated and in which the general conditions of balance become unfulfilled, and the other may be styled the *particular* type of musculo-nervous curvature, for in it only a few of the spinal muscles are affected, either with loss of power (paralysis) or increase of power (spasm), and the conditions of balance become partially deranged.

(1) **General musculo-nervous Curvature** arises from general debility or atonicity of the system, and consequently is liable to overtake any one in times of great constitutional weakness, and more particularly those whose growth is as yet incomplete, and

whose less vigorous tissues are, as a consequence, more unstable under strain than those of adults. For obvious reasons girls in the years between maidenhood and womanhood, and especially those who in the extravagant rapidity of their growth have taxed nature beyond its powers, are very frequently victims to this consequence of an exceedingly enfeebled condition. So also are patients convalescent after trying illness, more especially fevers, or collapse resultant on great mental or nervous exhaustion, when the vital energies of the bodily economy sink to a very low ebb.

What is noticed by those in the society of the sufferer, who observe only with a casual and unpractised eye, is, that there is to begin with a manifest indolence of disposition, a sluggishness of gait, and a disinclination to keep the body properly upright either in walking or sitting. The natural curves of the back become changed, the shoulders rounded, and the loins flattened; the small of the back is no longer well held in, and the elastic pliancy of the figure seems lost. Nothing graver is thought to be the matter perhaps with the sufferer than an addiction to wilful stooping and lounging habits; but this is wrong, for the patient may have the will but not the power to maintain uprightness. As time progresses, however, something more serious is found to be the case, for one of the shoulders (generally the right) becomes materially enlarged and elevated, the opposite one undergoing the reverse change, and marking the difference between the two with greater distinctness. If nothing is still done to control these changes, they become still more exaggerated, and the body being greatly deformed, it follows that the various organs of the body get misplaced, and the organic irregularities and ill health which have been styled the secondary results of curvature arise. The foregoing are the rough changes which may be casually observed by any one through the clothing.

The more minute and particular changes, such as may be established by those in the habit of making careful examinations of the nude back, take place in a series of four well-defined stages in the following order:—In the first stage the spinal muscles are becoming atonic and incompetent to do their work, so that after the least fatigue the body stoops and cannot long be held uprightly, nor can the spine maintain its true and healthy curves. In the second stage, that which before was *temporary* now becomes *permanent*, the natural curves of the spine being entirely lost, and the stooping being constant and confirmed. The first and second stage run without distinctness one into the other, only what commences as a temporary condition is consummated as a permanent one. In the third stage the osseous segments of the spine, falling still more away from muscular control, become displaced on each other in a lateral and rotatory manner, and in so doing cause the disturbance of the ribs and shoulders so well known, and also provoke other secondary restituent curves. The fourth stage commences when the osseous segments of the spine become, by mutual and uneven pressure on one another, accommodatively absorbed, and this causing an actual change in their shape, sets the seal as it were on deformity; for during the first three stages complete cure is possible; after the commencement of the fourth, ameliorative treatment only is possible. Each stage must now be gone into in detail.

(*a*) **First stage of general musculo-nervous Curvature.**—This first stage commences with bodily sluggishness and indolence. It owes its origin to the fact that the entire muscular system has become atonic. The spinal muscles are losing the disciplined obedience they pay in health to the stimuli which are sent by their proper governors, the voluntary and the gravital centres, from the seat of will

and balance. It was shown in the last chapter that the stimuli emanating from the gravital centre both governed the spine in its balancing duties as well as maintained the natural curves of the healthy spine as those best suited for performing the said duties; as, however, the muscles begin to be atonic and cannot obey these stimuli, so the natural curves of the spine begin to be lost, and the body to stoop and be ill-balanced. This is most obvious after any fatigue, or on depressing days, when the tone of the system is generally lower, and for similar reasons is more marked in the evening than in the morning. The will, it is true, has still power to correct for a time the result of this loss of tone, and so it happens that, if the sufferer is verbally corrected, an upright and natural position can be assumed; but this cannot long be maintained, as it entails a fatigue beyond the already feeble power of muscular endurance, and increased lassitude is the usual result. The fact, however, that the will still has control over the spinal muscles, and that the sufferer still can, if reminded, sit uprightly, leads to the erroneous conclusion that the stooping is due to bad habit and not to ill-health, a conclusion which is one of the commonest reasons why this musculo-nervous curvature is rarely caught and checked in its first stage.

Treatment.—It is just possible that if incipient curvature were recognised thus early the necessity for mechanical treatment might not arise; and that while, on the one hand, the general constitutional state of the body was strengthened by tonic medicine, nourishing diet and fresh air, the will, on the other hand, could be used as tutor to the enfeebled muscles, and that under carefully administered gymnastic exercise the muscles might be restored gradually to their proper strength, and curvature altogether averted. The exercise by which this might be done should be of the regular character of a drill, and should aim

both at strengthening the back muscles generally, and also at encouraging the act of upright balance, and so restoring the power to permanently re-establish it. Writers on gymnastics have devised many series of figures for performance with this view, but the simple setting-up drills in use among soldiery are perhaps the best, and are to be learned from any drill-sergeant. These done gently at first, and with increased vigour as time progresses, bring the muscles into the desired strengthened condition.

As a matter of experience, however, it is safer to treat the curvature even at this stage by the appliance used in the next stage of this curvature; which appliance it will be shown is practically a gymnastic master, and exercises the muscles till they reacquire their healthy tone, but at the same time relieves the spine of a great deal of the work it has to do, thus making the exercise lighter and continuous, in contradistinction to that given by gymnastics, which is more fatiguing and is intermittent.

And this fact is forcibly illustrated by the following case, which shows the advisability of giving immediate mechanical support, as well as the mishaps that may arise if gymnastics are relied on; and being the case of a young man, and not of a girl, it is the more affirmative, seeing that the changes in men are usually less rapid.

Mr T. R—, the nephew of one of the most distinguished surgeons in London, became subject at about the age of fifteen to great weakness of the back and an inability to long maintain the erect position. He came to town, and as no deformity at all was apparent, but merely muscular weakness of the back, he was ordered, under eminent advice, to the seaside, placed on tonic medicine and diet, and prescribed to practise certain exercises to strengthen the muscles, as well as to give them periodical rest during the day by lying down. This treatment was

faithfully carried out, but while it was in progress distinct curvature of the common musculo-nervous type set in, and progressed through all its stages with such rapidity that in a few months time the spine had acquired a double curve of the severest kind, while the ribs had rotated in such a way that the greater part of the back seemed constituted by the ribs of the right side, and the greater part of the chest by those of the left side. Finally, intense intercostal pain set in, and the action of the heart and lungs was impeded by the distortion of the chest walls. He then came to town again, and was instantly sent by his uncle to Mr Erichsen, who sent him on to the Author, with instructions to devise such an appliance as should check the curvature, relieve the nerves from pressure, and enlarge as far as possible the vital cavities, and so relieve their contained organs from constriction. The appliance was constructed, and has now been worn three years. Within a fortnight all pain went, and it has never recurred, while the general shape of the figure and the capacity of the vital cavities of the body have been much improved. The curvature of course remains, and ever will remain, the case having reached the latest stage of musculo-nervous curvature before any mechanical treatment was adopted, but the back is now, with the aid of the support, mechanically strong, and the patient is able to take exercise and undertake exertions which previously were impossible to him. It seem obvious then that a case of this kind (and there are many such) should be mechanically stayed at the outset, and that too great a reliance should not be placed on gymnastics to stop matters in the first stage of common musculo-nervous curvature.

What, however, not unfrequently happens when the danger of a case is mechanically averted in the earliest incipient stage, is this: the friends of the patient, disappointed at finding no appearance of

the curvature to guard against which the appliance is worn, come very often to the erroneous conclusion that because the curvature has not shown itself the appliance must therefore have been unnecessary altogether, and they entirely ignore the work that has really, although invisibly, been accomplished. Thus, while the use of an appliance as a preventive in the first stage is unappreciated, its use in the second stage, where, as will be seen, its service is immediately obvious, is considered most satisfactory; thus it is that people are more pleased with cure than satisfied with prevention. As a matter of prudence, however, when the first stage foreshadows the advent of the second, it is wise to adopt the mechanical treatment as soon as possible, and not to trust entirely to gymnastics.

(*b*) **Second stage of general musculo-nervous Curvature.**—The first stage passes into the second when the stooping and the loss of the true curves of the spine, which before were a temporary habit, become a permanent and uncontrollable practice. The spine still retains a position true to the middle line, and there is as yet *no lateral* curvature, but the natural antero-posterior curves become modified in a peculiar manner for the following reasons:

The entire body from foot to crown is arranged in a series of curves, of which the ordinary and natural spinal ones form but a portion. The entire muscular system governing and maintaining this arrangement acts in subordination to the gravital centre and law in the manner hitherto described. When, therefore, the musculo-nervous system is so far atonic as to begin to fail to maintain these curves by diminished obedience to gravital impulses, then a static compromise is struck and a more facile mechanical position assumed by the substitution of longer and fewer curves for more and shorter. This tendency, affecting the spine *inter alia*, initiates the

obliteration of the lumbar curve, with alteration of the pelvic plane and the modification of the dorsal and cervical ones, while the muscles which, when in healthy tone, hold the shoulder blades back allow them now to drop forward. These changes are recognised as straightening of the loins and rounding of the back and shoulders, and their nature will be more easily seen by a glance at the adjoining figures 2 and 3, the one presenting the well-set upright form, and the other the atonic form so characteristic of this stage of curvature.

Treatment.—Now, the muscles of the back and spine, although they are so far enfeebled as to be unable to maintain the natural shape of the spine, are, nevertheless, by no means without power; they have only lost a portion of their power. The appliance, therefore, that must be worn to treat this defect, must only aid the muscles in doing their work, and must not do the entire work for them. For the treatment of weakened muscles lies in this, that such auxiliary help shall be given them as shall enable them to do their duty, so that as they act they shall gradually resume strength by exercise, and the auxiliary help shall be gradually decreased in power while the muscles increase in power, until at last they need no auxiliary aid at all.

This may be made clearer by putting it numerically. Supposing the healthy muscles of the spine exert a force equivalent to 10 to maintain the true curves of the spine, and supposing through atonicity the extreme power they are capable of exerting is equivalent to 7, then there is a deficiency represented by 3 and the true curves are lost. The appliance which is to remedy this deficiency and restore the curves must supply an active force of at least 3. In practice it is found better even to supply an auxiliary force of 4 or 5, and then the weakened muscles can act conjointly with the aid supplied and can easily do their work, and by the

mere exercise of doing it begin to increase again in strength from 7 to 8, to 9, and finally to 10, so that ultimately artificial aid becomes unnecessary. Now, as the muscles of the back can no longer exert sufficient force to keep the chest up, the shoulders back, and the loins in, the appliance that has to be worn must not only supply the lost force of the muscles, but must direct that force in such a way as to restore the lost shape also of the figure.

The appliance to do this will be thus constructed. A base-hold is taken on the pelvis by a thin metal band, encircling it in the proper line, passing round from the sacrum to the pubic bone and back again to the sacrum. At the pubic bone there is a softly-padded enlargement of the band, which enlargement rests on the pubic bone and gives the circlet a certain stability. The circlet is actually maintained in position by its own tightness on the pelvis, it being tightened to a degree consistent with stability, and not inconsistent with comfort. Next, starting from the base circlet behind, there arise two finely tempered metal strips, which pass up the back resting on the muscles which overlie the transverse processes of the vertebra and the heads of the ribs; these strips at the top of the back join each other in an arch, and between them an interval is left so that the spinous processes are not touched.

There springs from each of these back bands, at the level of the armpits, a spring-wire horizontal branch, which passes straight across the back to the armpit of its own side, through the armpit, and

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FIGS. 2 and 3 are diagrams intended to represent the changes that take place in the curves of balance of the body when the system becomes atonic. Fig. 3 exhibits the upright, tonic, and healthy position of the body, which is pervaded by a curve with six convexities while the arches of the feet are well set up. Fig. 2, on the contrary, shows the atonic stooping position of the body (temporary in the first stage, and permanent in the second), the curve pervading which has but two convexities, while the arches of the feet are flattened, this flattening or valgus being a very usual accompaniment of the atonic condition which starts this type of curvature.

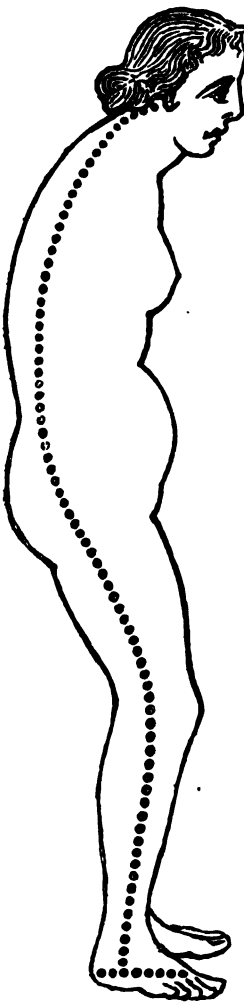

FIG. 2.

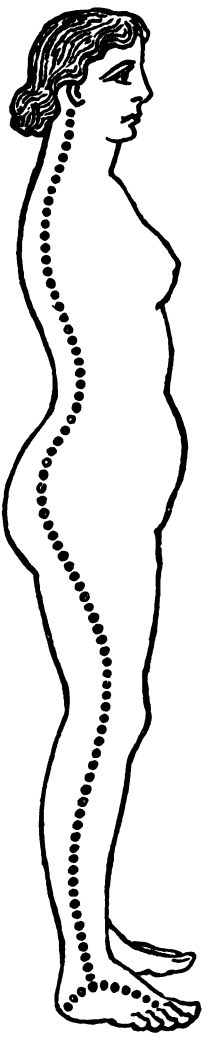

FIG. 3.

under the arm, and which curls round to appear in front and terminate in a plate, pressing against the top of the shoulder and holding this latter back. These are termed arm-pieces. Lastly, the appliance is completed by an elastic belt, which surrounds the lower abdomen and is fastened to the back bands in the loins, thus holding the back bands closely to the spine and supporting the abdominal walls.

The use and intention of the entire appliance is to give the aid lately mentioned. In doing this the back bands play the principal part, the other portions being rather holds than agents, although they have subsidiary intents of their own. The arm-pieces help the muscles of the scapula to hold the shoulders back as well as to control the level of the shoulders, the belt aids the muscles of the abdominal walls, and the pelvic circlet can be at pleasure modified to control the angle of the pelvis and, by this means, uterine malpositions. These uses are, however, secondary somewhat to that of keeping the back bands in apposition to the spine. The back bands and the spine are thus as nearly as can be one, and the spine being deficient in certain muscular power the spring back bands are set to supply by their force the deficit, and the spinal muscles are aided to aid themselves, as explained. The whole appliance is at sword temper, supple, and pliant. As the body bends it bends. It fits with such closeness as to be undetected by sight, and even by casual touch, for since its hard parts come in the position of hard parts of the body its presence is unsuspected.

The manner in which the appliance acts is further explained diagramatically when the two figs. (4 and 5) are contrasted. In Fig. 4 the appliance has merely

The adjoining figures show the application of the appliance for the first and second stage of the general musculo-nervous type of curvature. Fig. 4 represents the atonic body before the appliance is brought into action. Fig. 5 shows the change produced by the spring action of the appliance when *in situ*. Figs. 6 and 7 exhibit the front and back views of the appliance when on, and show how it is that it is absolutely imperceptible beneath the clothing.

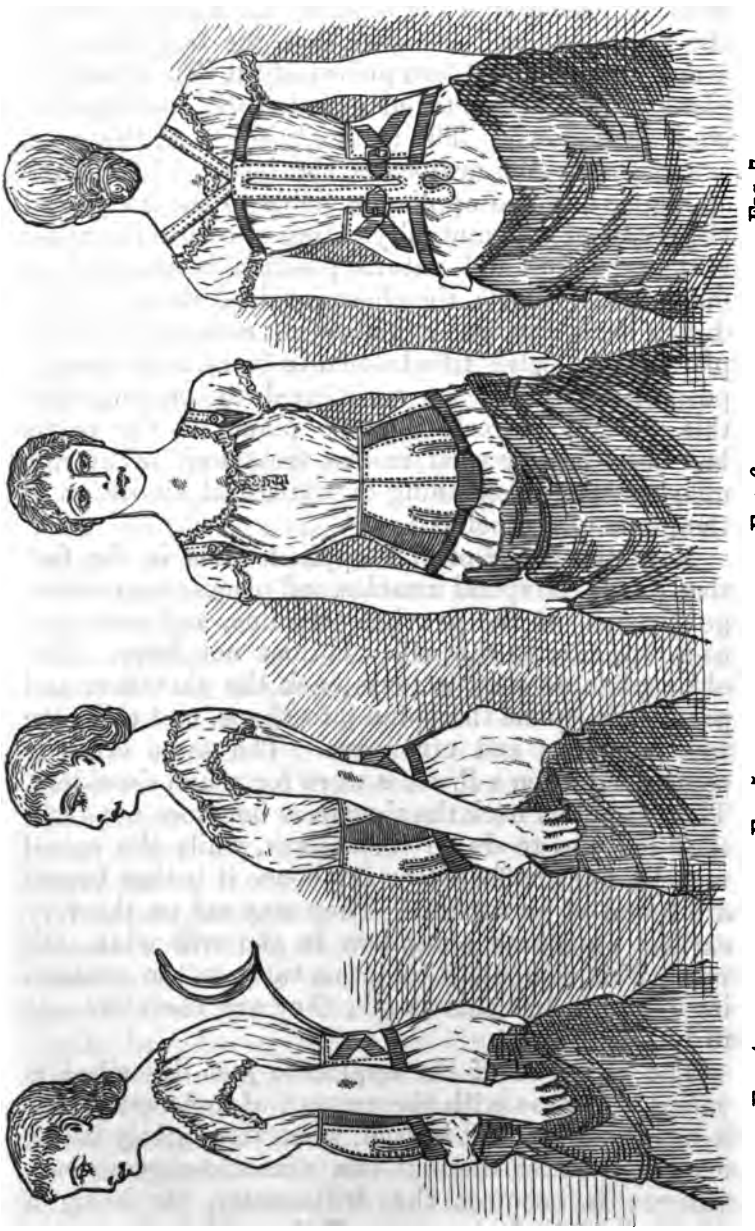

FIG. 7.

FIG. 6.

FIG. 5.

FIG. 4.

been fastened round the hips but not adjusted under the arms. It will be seen that the body has the atonic appearance shown previously at Fig. 2, that the plane of the pelvis is tilted up anteriorly, and that the chest falls down. The moment, however, the arms are put into the armpieces the body yields to the appliance and the appliance yields to the body, and the result of this mutual yielding of one to the other is that the true and natural position is assumed as indicated by Fig. 5, the chest is raised, the shoulders drawn back, the true spinal curves restored, and the plane of the pelvis tilted down in front to its proper position. (It may be mentioned in passing that this method of restoring the plane of the pelvis has been largely used in the treatment of uterine misplacements depending on unnatural alteration of the plane of the pelvis.)

Now, the virtue of this appliance lies in the fact that it aids the spinal muscles, and places them within governance of the gravital stimulus, and acts also as a reminder to the will. It does not force. The old appliances used to truss back the shoulders and practically splint the spine into shape, and this plan was fallacious and erroneous. The same error is committed when a *Brace* is worn for round shoulders. The brace ties back the shoulders but does not train their muscles to do so themselves, while the spinal muscles are unaffected by it; hence it is that braces are found of no service. They may act on the very earliest stages as reminders to the will while the will still is competent to act as tutor to the weakening muscles, but this is all; they are therefore not to be relied upon.

The strength of the appliance just described is varied of course with the amount of deficient power it has to supply. It is used, when very lightly made, even in the first stage of this musculo-nervous curvature; it becomes the drill-master, for being a constant reminder to the will it drills. It is fre-

quently used now by the weaker sex as a mere preventive against fatigue or back-ache, more especially where the duties of their station or of their profession put a more than ordinary strain on the muscles of the back. Not a few eminent actresses have habitually used it, the less to be fatigued by the constant necessity they have to maintain an upright figure; and for a similar purpose it is beneficial to those who, riding for long afternoons in their open carriages, sit uprightly with their back unsupported. In these cases the appliance is used rather for weaknesses, but by quoting them is shown the extension of which its elastic principle is capable.

(*c*) **Third stage of general musculo-nervous Curvature.**—The third stage commences when the spine, which up till then has only altered in an antero-posterior direction, begins to develop a tendency to curve laterally. The whole of the deformity of this stage arises from that simple tendency; the rotation of the vertebræ (or osseous segments of the spine), the spreading of the ribs on one side, the rising of the shoulder on the same side, and the establishment of secondary curves—all these follow one after the other as a simple consequence of the disposition the spine evinces to curve laterally, and are marked to an extent which agrees with the amount of the lateral curve.

This lateral curving which initiates the third stage is peculiar from its regularity. It may be said to invariably commence in the dorsal region, and it most usually (perhaps in ninety-eight cases out of a hundred) has its convexity to the right side. The reason of this regularity of direction and position has never been fairly explained, nor does it seem clear; but the author is inclined to believe that it is the exaggeration of that slight lateral curve which is known to exist in all healthy spines, and which has already been alluded to and explained in the

first chapter of this work (p. 16). As has been said, however, when once this lateral curve does start all its consequences are easily explicable.

The rotation of the vertebræ is due to the fact that from the peculiarity of the three surfaces by which each vertebra touches the other, it is impossible that lateral curving can take place without rotation; this can be proved on the bones of the dead subject, and an interesting anatomical toy which embodies this proof has been made (the originator of which, the Author believes, was Dr Judson). This being an experimentally proved fact, it is unnecessary to enter into the description of the peculiarities of the contingent vertebral surfaces that cause it; it is sufficient to say that just as a screw cannot be withdrawn from the wood in which it is fixed without rotation or unscrewing because of the peculiar shape of its surfaces, so the vertebral segments of the spine will not admit of lateral curving without at the same time rotating, and lateral and rotatory changes are therefore coincident. The changes of the ribs are equally simple in their explanation. For the ribs are actual appendages of the vertebræ on the dorsal region, so firmly bound to them as to be practically part and parcel with them. So that whatever changes the dorsal vertebræ undergo, consequent ones will be dictated to the ribs. As therefore the lateral spinal curve forms, the ribs, which were previously parallel, will spread out fan-wise on the convex side of the curve, and will similarly collapse on the concave side of the curve. In addition to this, as the vertebræ themselves rotate backwards on the convex side of the curve so will also the ribs, while on the concave side of the curve both vertebræ and ribs rotate forwards. These vertebral and rib changes may be summed up by saying that the entire thorax enlarges in all directions on the one side, and diminishes on the other, an alteration which cannot

fail to effect its contained organs, as will be alluded to under secondary symptoms later on.

The shoulders in their turn follow the ribs, for the shoulder-blades merely overlie the ribs, and suffer no restriction in movement except that imposed by the clavicle, by which restriction, however, they are led to assume their characteristic positions on the sides of the altered thorax, positions which are popularly expressed by saying that "the shoulder has grown out on the one side of the body and dropped on the other side."

Now, it will be apparent that the changes that have just been described, and which are as far as possible portrayed in Fig. 8, must entirely upset the lateral symmetry of the body's weight and form, for (taking the usual case) the right side of the body in the region of the thorax becomes greatly preponderant over the left side, and the burden which the spine as a whole has to bear is then one-sided. The restituent tendency of the spine at once initiates the formation of a lateral curve in the loins with a direction opposite to that in the back; for although the tonicity of the spinal muscles had so far fallen below par that they become unable to maintain the true curves of the spine, they have nevertheless sufficient potency left to determine the formation of restituent curves if needs be. This restituent curve has usually been styled "secondary;" as it increases it involves the pelvis, altering the level of the hips and lower limbs, and producing a characteristic peculiarity of gait in walking.

Thus the third stage comprises a number of changes, all of which have a mechanical connection. The spine commences to curve laterally, the spinal segments as a consequence rotate, the ribs follow the segments, the shoulders follow the ribs, and the secondary restituent curve follows the disturbed distribution of weight that springs from the primary curve. In the previous second stage the spine

bowed in one single plane of direction, and the centre of gravity of the mass of the body altered also in this plane, in which, likewise, both restituence takes place, and in which also the power of the mechanical appliance used in treatment has to be directed. The force employed had, therefore, to be active, simple, and directed only in that one plane. In the third stage it is quite otherwise. The trunk yields simultaneously in a spiral and lateral direction, and the mechanical force employed to meet this contingency must be active, spiral, lateral, and in the reverse direction.

The expression was used a few lines since, "the trunk yields," and advisedly so; for, if the attention is pinned, as it were, too strictly to the spine, one is apt to lose sight of the fact that the other contemporary changes of ribs, shoulders, and loins, are coincidently going on. It is, therefore, wise to embrace all the changes in one glance or thought. The trunk, then, be it said, is moving spirally and laterally, the spine being the stalk of its movement, and it is the trunk as a mass that has to be replaced.

Treatment.—Now, the mechanical replacement of this mass (or, in other words, the mechanical treatment of the third stage of this curvature) consists first in buoying up the mass itself, so that it may move more easily under the force employed, and next in securing by mechanism the proper application of such a force as can simultaneously control the numerous changes which were shown to pertain to this stage of curvature.

As regards the buoying of the mass. Just as a chair goes more easily when on castors, or a large stone is moved with facility when buoyed in water which cannot be stirred in air, so the mass of the trunk

FIG. 8 is a sketch of the changes which deform the body in the third stage of general musculo-nervous curvature, and shows the lateral curving of the spine, the enlargement of the one side of the thorax by rotation of the ribs, and the rising of the shoulder on the same side.

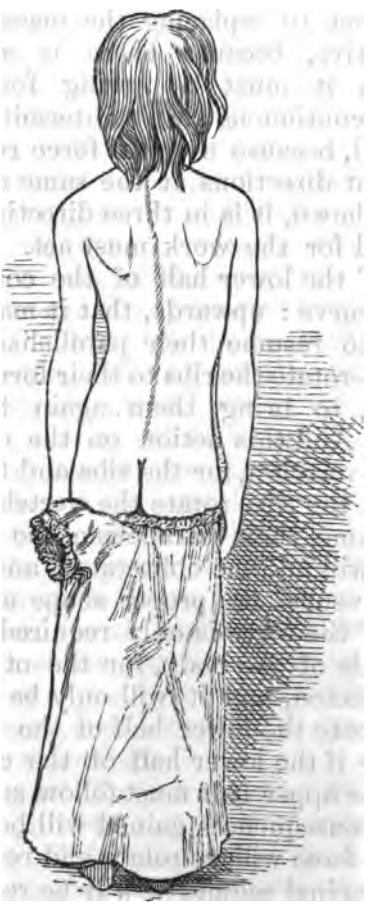

FIG. 8

which has slipped round can be more readily restored to its place if it be buoyed or uplifted by some arrangement (such as crutch pieces under the arms), by which, further, the burden of its weight will be in great degree taken off the spine.

With respect to replacing the mass; the force must be active, because there is actual work to be done; it must be spring force, because it has to be continuous and unintermittent; and it must be spiral, because a spiral force really acts in three different directions at the same time, and, as will be now shown, it is in three directions that the force required for the work must act. It must act on the ribs of the lower half of the convex side of the primary curve: upwards, that it may cause the spread ribs to resume their parallelism, forwards, that it may re-rotate the ribs to their former position, and laterally, to bring them again towards the middle line. And this action on the ribs is really action on the vertebra, for the ribs and the vertebræ are one. As the ribs rotate the vertebræ will; as the ribs resume their parallelism the vertebral or spinal curve will become obliterated, and the thorax as a whole resume its proper shape and position. The action of the force is only required on the ribs of the one side of the body, for the other side will be equally affected, and it will only be required on the ribs opposite the lower half of the convexity of the curve, for if the lower half of the curve can be eliminated the upper half must follow suit. So that the train of consequences gained will be as follows:—The spiral force will re-rotate and render parallel the ribs, the spinal segments will be re-rotated and made true one above the other, the primary spinal curve will be thus eliminated and the thorax will resume its proper shape; the shoulders will drop into their true position on the truly-shaped thorax, and the secondary curve will gradually disappear as it came.

The appliances which shall carry out the principles just laid down vary in strength and construction, because just as the transition from the second to the third stage of curvature is not abrupt, so the appliance used at the beginning of the third stage will partake of much of the character of that used at the end of the second stage, and as the third stage advances in deformity so the appliances will have to be modified in form to meet these differences.

When the lateral curve has only just shown itself (as will be determined by the method of examination given at p. 63) then the apparatus will be of the form shown in Fig. 9, and, as will be observed, identical with that used in the second stage, but with the addition of a special plate to press on the rotated ribs. This plate is fastened to the back-boards of the appliance by a spring pedicle, and it is this spring pedicle which gives to the plate its spiral direction and power. Such an appliance in cases of incipient lateral curve is sufficient.

When, however, the lateral curve and rib-rotation is greater, then there will be the necessity for increased rotatory power, which will be obtained not from the rib plate alone, but by constructing the whole apparatus with such a spiral twist that when it is worn its entire power will be constantly exerted in rotating the parts of the body back into their correct position, the thorax in the one direction, and the pelvis in the other.

The appliance for this purpose will still be identical in shape with the previous one (Fig. 9), only the rib plate will be larger, because the lateral curve of the spine is greater and the ribs are more involved. The principal difference, however, will be the rotatory twist, which will pervade the whole apparatus, and which is given by the twisting of the spring-tempered back-bands. By this means the thorax, which is held above by the arm-pieces and rib-plate, and the pelvis, which is held below by the pelvic

bands, are made to rotate in different directions, this being exactly what is wanted to restore the body to its form.

This will be better appreciated if the body of the patient is imagined as looked down upon from above, and viewed by any one immediately over the head of the patient. The thorax can then be easily seen twisted in one direction, and the pelvis in the other direction. If the appliance intended to meet this condition be similarly viewed from above, it will be seen that the parts intended to grasp the thorax and the pelvis respectively show an analogous twist, but in a reverse direction.

It will be seen, then, since the parts of the patient's body and the parts of the appliance have tendencies in different directions, that when the appliance is adapted to the body of the patient there will be a constant battle between the two, an antagonism which, although gentle, can, if properly directed, be made to terminate in favour of the appliance, which will gradually and gently force the body into its proper shape.

In both this and the previous appliance the buoying of the weight of the trunk is performed by the arm-pieces, by which also the level of the shoulders can be controlled.

When the lateral curve is greater still there is a more potent appliance that can be used, which although carrying out in a similar way the two great principles of buoying and of actively rotating the trunk, differs entirely in structure from the previous appliances.

Fig. 10 represents it on the body, and it will be

FIG. 9 represents a form of appliance for the third stage of general musculo-nervous curvature, there being a rib-plate for the rotation of the trunk, and the whole appliance having a spiral twist antagonistic to that of the body.

FIG. 10 represents another form of appliance for the third stage of general musculo-nervous curvature. The crossbar mentioned in the description is left out to more clearly show the plate and spring.

FIG. 10. FIG. 9.

seen to consist of a light metal band taking a base hold round the pelvis, and kept securely in that position by a gussetted webbing band, which is accurately moulded to the hips. From the sides of the metal pelvic band rise two lateral uprights terminating in crutches, and connected at the level of the armpits by a cross band, which gives them stability. These uprights carry much of the weight of the upper part of the trunk direct to the pelvis, and so relieve the spine from weight, and they likewise buoy the trunk so that the active rotating force, next to be described, can more easily exercise its power. The active agent itself is a coiled spring. it arises on the one side from the front of the steel pelvic band opposite the anterior iliac spinous processes, and thus, as it were, indirectly from the bony pelvis itself; it passes round the back of the body to the prominent ribs of the other side, and terminates in a plate which overlies these ribs and distributes its force to them in such a combined spiral, lateral, and elevating manner as has previously been shown to be requisite.

When the appliance is *in sitû* on the body, the spring fits with almost close accuracy, and its powerful force is comfortably exerted in directing the ribs in the directions already mentioned. When the appliance is off the body the spring coils up in accordance with the set given it prior to tempering.

This concludes the mechanical treatment of the third stage. Up to this point the deformity of the spine is curable. As, however, the deformity progresses up to this point by stages, so the cure has

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FIGS. 11 and 12 represent an advanced condition of the fourth stage of general musculo-nervous curvature, in which there has taken place not only accommodative absorption of the vertebræ, but alterations in the ribs by flexion. This case is described at p. 38, and had passed with regularity through the previous stages: it was sent by Mr Erichsen to the author, and the level of the hips and shoulders have been re-established, while the chest and abdominal cavities have been improved as far as possible under treatment.

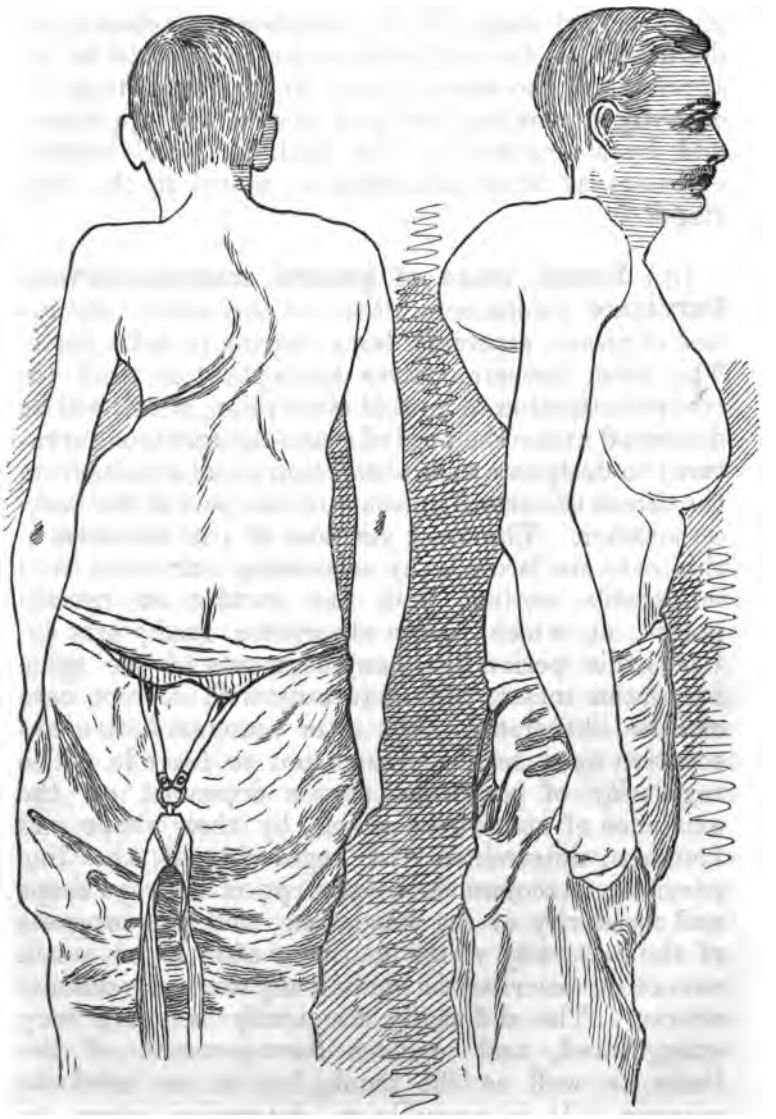

FIG. 11. FIG. 12.

generally to be made through the same stages. Thus, a patient in the third stage wears the appliance for that stage till the rotato-lateral element of deformity has been eliminated, and then takes to the appliance of the second stage, finally completing the cure by depending less and less on the appliance, and by strengthening the back by such healthy exercises as were mentioned as useful in the first stage.

(*d.*) **Fourth stage of general musculo-nervous Curvature** commences when *accommodative absorption* of tissue, especially bony, begins to take place. The term accommodative absorption is used (in contradistinction to morbid absorption, which will be described under the head of osseo-ligamentous curvature) to designate that absorption which results from the direct unnatural pressure of one part of the body on another. The bony surfaces of the vertebræ in this case are brought by increasing curvature into intolerable contact with one another at certain points, at which points absorption finally sets in. Up to this period the bony segments of the spine have been intact, and deformity with correct care can be obliterated; but after accommodative absorption once sets in this is not so feasible. The regularity of preceding stages depended on the existence of structures which, by their shape and firmness, determined the regularity of the line pursued. Accommodative absorption destroys shape and regularity at the same time, and the progress of the deformity which continues after it has set in cannot be described as holding any distinctly definite course. The deformity frequently becomes very exaggerated, and involves derangements of the limbs as well as the trunk, but in an indefinite manner. It is possible to determine, when an extreme case comes under observation, how the deformity has been produced; but it would be

impossible to predicate in the early stage of any case what precise course it would pursue when once accommodative absorption had set in.

Treatment.—In consequence, then, of the irregularity of the fourth stage, a great variety of different deformities are met with, and the appliances used for them will be equally various. The principles, however, which govern the mechanical treatment of the fourth stage are fixed and definite. First, the further progress of deformity must be checked, and this is usually easily effected by correctly propping or staying the trunk. Next, the spine must be relieved from its burden by proper crutch-pieces under the arms. Then, although the spine itself cannot be restored to straightness, still the true and even level of the hips and shoulders may usually be regained. Again, the cavities which contain vital organs must, if they have become diminished or cramped by deformity, be enlarged and expanded by proper mechanical treatment, and this is not generally impossible. It is true that the appliance, as a rule, has to be worn perpetually, because if removed the body begins to lapse again into error on account of the mechanical instability of the deformed spine, which constitutes the only solid structure between the upper and lower portions of the body; still this is but a slight price to pay for the permanent comfort and health that are thereby ensured.

The appliances used in this stage have not the pointed activity of those previously described, but the mere fact that changes in the body can be, and have to be, produced, indicates that an active appliance is still necessary. When, however, such changes in the bodily form have been produced as were considered needful, then the appliance ceases to have to do any other work than the mere maintenance of shape, and may be nearly passive to effect this.

An absolutely passive appliance, such as a splint,

does not however do, because it will neither regulate the level relationship which should be made, if possible, to exist between shoulders and hips, nor will it tend to increase and maintain the capacity of the vital organ cases. This is merely mentioned now in passing, but will be more fully alluded to later on in discussing splints.

The forms of the appliance for this stage are, as might be expected, advanced developments of those appliances used in the last stage, just as this fourth stage itself is an advanced condition of the third.

Fig. 13 portrays an appliance which is an advanced form of the type of Fig. 9, and has the same plan precisely of holding the pelvis, only each shoulder has a shoulder-plate dedicated to it for control, and the arm-pieces are further stayed by lateral uprights (if necessary) passing from them to the pelvic springs. This form of appliance is best suited to cases where the lapse has been mostly in an antero-posterior direction.

Fig. 15, on the other hand, represents an appliance which is an advanced form of the type of Fig. 10, the hold on the pelvis and lateral uprights being identical. The addition to these parts of lacings which envelope the trunk, and of such accessory steel bands as may be required in particular cases to give special direction and power to these lacing pieces, constitutes this appliance as less active but more general in its action on the body. This form of appliance is suited to cases where the lapse has been chiefly lateral in direction.

Fig. 14 exhibits a pair of well fitted and stiffened

The adjoining figures represent appliances for the fourth stage of general musculo-nervous curvature. Fig. 13 is an advance on the type of Fig. 9, and is suitable where the curvature is chiefly antero-posterior. Fig. 15 is an advance on the type of Fig. 10, and is suitable where the curvature is chiefly lateral. Fig. 14 is an appliance for maintaining the shape of the trunk, regulating at the same time the level of the hips and shoulders, and relieving the spine of its burden.

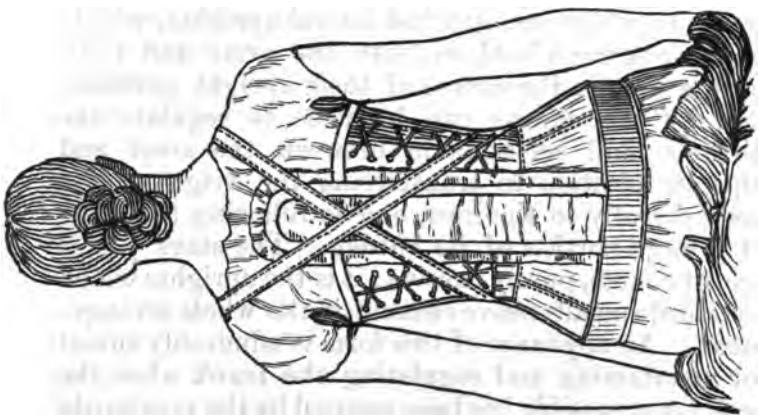

FIG. 15.

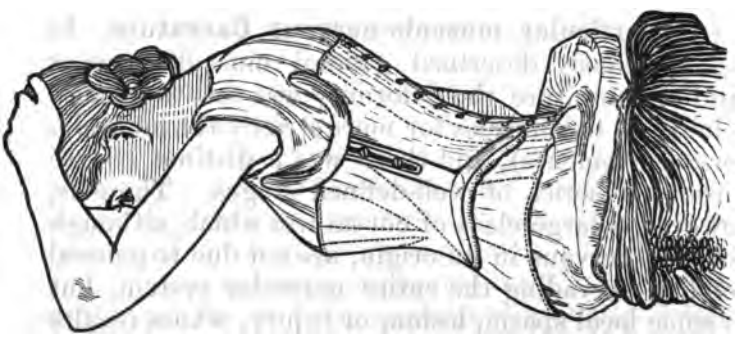

FIG. 14.

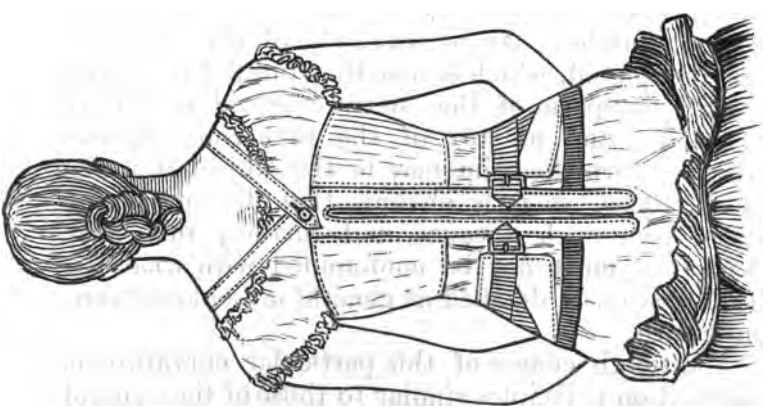

FIG. 13.

stays, to which are attached lateral uprights, which, while securing a hold on both the arms and hips, have a slide in the course of their upright portions, and by this means can be made to regulate the distance and relationship between the arms and hips, in addition to transferring the weight of the body directly to the hips, and so relieving the spine of a large portion of its burden. The stays *per se* are, of course, purely passive; it is the uprights which constitute an alterative element in the whole arrangement. An appliance of this form is admirably suited for maintaining and regulating the trunk when the best form possible has been secured by the previously described appliances for this stage of curvature.

(II) **Particular musculo-nervous Curvature.**—In the previously described general musculo-nervous kind of curvature the deformity was due to general debility of the muscles (or more strictly the musculo-nervous elements), and there was a distinct course through a series of well-defined stages. There is, however, a large class of curvatures which, although musculo-nervous in its origin, are not due to general debility pervading the entire muscular system, but to some local spasm, lesion, or injury, whose results only affect one *particular* muscle or one particular set of muscles. As an example of this, wryneck may be quoted, which is usually admitted to be due simply to spasm of the sterno-mastoid muscle of one side; and as any of the numerous muscles which govern the spine may be the subject of spasm or paralysis, so it is obvious that deformity may arise from such a cause, and further, that such deformity must not be confounded with what has been previously detailed as general musculo-nervous curvature.

The rough course of this particular curvature is pursued on principles similar to those of the general curvature. The spasm or paralysis of any muscle

governing the spine will lead to a primary curvature being established, and this will provoke a secondary restituent curve. This process is, of course, straightforward, but what is peculiar about this particular curvature is that the primary curve has no regularity in the precise spot of its appearance, which will vary with the muscle or muscles affected, whereas the general curvature is very regular in position.

The mechanical treatment of curvature of this particular type will consist in counteracting the irregular variations in strength of the muscles by properly applied active elastic force. For the muscles of both sides of the spine have in health equal force, and antagonise each other evenly. If, however, one muscle becomes stronger by spasm, it will ovecome the antagonism of its opposing muscles and drag out of their place the parts of the body to which it is attached. On the other hand, if a muscle suffers loss of power or becomes paralysed, then it will be overcome by its antagonising muscles, and will permit the parts to which it is attached to be drawn away from it out of their place. The mechanical appliance, then, must stay and support the erring parts of the body so deranged, and by active elastic force must restore them to their place and render the balance between of the muscles just by aiding the weaker till they are equivalent to the stronger. If, after this has been done, the paralysis or spasm disappears with time, then the appliance will cease to be needed; but if the paralysis or spasm be continuous, as often happens, then the appliance must be continuously worn.

Examination of the Spine to detect musculo-nervous Curvature.—It is very certain that if a careful and methodical examination of the spine were made when persons began to show any signs of weakness or lack of tone, very many cases of musculo-nervous

curvature would be detected when only incipient, and could then be checked at the outset instead of being, as is usually the case, allowed to proceed till their cure becomes attended with difficulty. The fact, however, that the progress of this kind of curvature is unattended with pain until it reaches an advanced stage is one reason why a proper examination of the back is frequently postponed until actual suffering calls attention to the fact that something is really wrong.

The following method will be found a very just one for conducting an examination of the spine with a view to detecting musculo-nervous curvature.

The patient should have her boots removed, the body should be bared as low as the great trochanters, and she should be placed with her back to the light of a window and her face towards the dark part of the room, which will act as a background and render the outline of the figure more prominently clear. The floor on which she stands should be level, the heels should be together, and the legs straight, care being taken that the knees are not bent; she should then be instructed to hold herself loosely upright, but without any stiffness or constraint, and to let the arms hang freely at her sides. While the patient is in this position the examiner will find the crests of the ilia, and by placing his fingers on them to indicate their position, he will note whether they are even, and in the event of their being so will know that the pelvis is level and the *base* therefore of the spine is true. The arms should next be glanced at, and if they are similar in size there can be no reason that any difference in their weight should have caused the *burden* of the spine to be untrue. And

FIG. 16 is a diagram to show the position in which an examination for musculo-nervous curvature should be made, and there are indicated by transverse lines those parts that should be recognised as level in the true figure, namely, the iliac crests, the folds of the buttock, the lower angles of the scapulæ, and the upper borders of the shoulders.

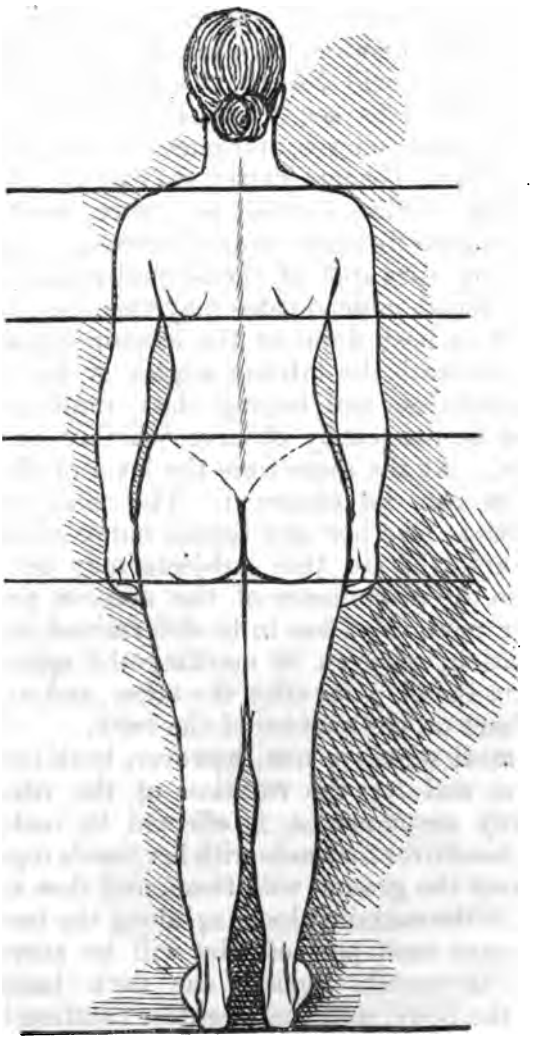

FIG. 16.

if both *base* and *burden* are true there will exist no *extrinsic* provocation to curvature (p. 24). The back can now be casually glanced at to note whether it has a feeble or atonic appearance, a thing which a practised eye will discern at a glance. The spine will be scanned to see whether it has lost its true antero-posterior curves, and more especially whether the loins have become flattened (Fig. 2), and at the same time notice should be taken whether the shoulders have become rounded through separation and falling forwards of the shoulder-blades. The level of the shoulder-blades may then be examined, and this is best done by the examiner placing his thumbs beneath the inferior angles of the patient's shoulder-blades, and having thus indicated their position he can easily observe whether or no they are even. At the same time the level of the entire shoulders can be observed. The next point to determine is whether any lateral curve of the spine exists, and this in thin subjects may be obvious owing to the prominence of the spinous processes, in fatter persons it has to be determined by digital examination, or even by marking the spinous processes on the skin one after the other, and so obtaining a chart on the surface of the back.

The most sensitive test, however, both for lateral deviation and for the rotation of the ribs which invariably accompanies, is effected by making the patient bend over forwards with her hands together as if to touch the ground with them, and then to slowly rise while the examiner looks up along the back. By these means each pair of ribs will be successively thrown in profile against the dark background behind the body, and the slightest rotation back on

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FIG. 17 is intended to explain the position in which lateral curvature and rotation are most easily recognised.

FIGS. 18 and 19 show how the pairs of ribs come into profile as the patient rises from the bent posture, any rotation being thus easily detected with great delicacy.

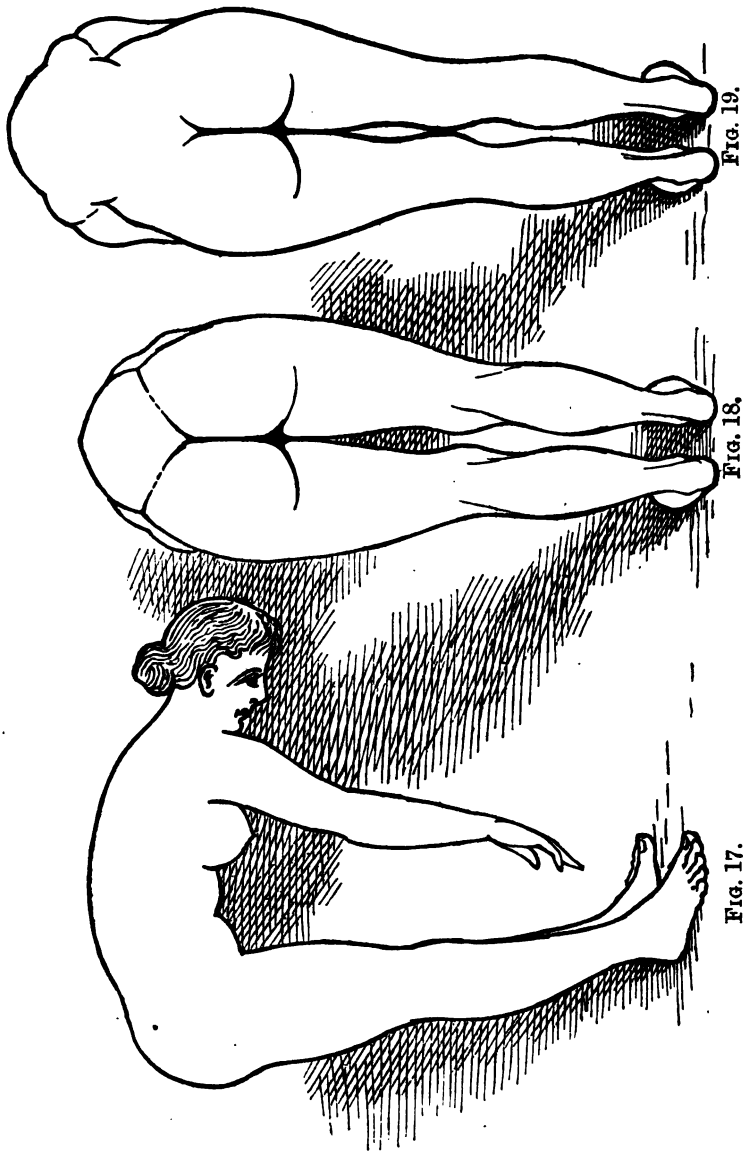

FIG. 19.

FIG. 18.

FIG. 17.

the one side, or forwards on the other, will be appreciable with the greatest refinement, while the throwing forwards of the arms withdraws the shoulder-blades from the ribs and exposes the latter to the greatest extent. This test for rotation is exceedingly delicate (Figs. 17, 18, 19).

By the results, then, of an examination conducted as above described, musculo-nervous curvature, as well as its separate stages, can be instantly detected. Thus general lack of tone in the back will be indicative of the first stage of *general* musculo-nervous curvature, and will be readily recognised by a practised eye. Flattening of the loins, rounding of the shoulders, and unnatural separation of the shoulder-blades, will mark the second stage. The appearance of differences in level of the shoulder-blades and shoulders, with rotation of the ribs and lateral curving of the spine, will determine the third stage. The advent of the fourth stage, or the fourth at which accommodative absorption sets in, is a matter that can be judged better by experience than by rule, but here, again, practice, coupled with past opportunities of post-mortem examination, will be a guide.

As regards *particular* musculo-nervous curvature, a similar exhaustive method of examination will expose any deformity which may arise of this type, and the fact that such deformity has not the regular and well-known appearance of the *general* type, will at once serve to class it as a case of the particular type.

B. Osseo-ligamentous division of intrinsic Curvature.

Osseo-ligamentous curvature or disease (synonym angular curvature, Pott's disease) is that kind of curvature which originates from morbid disintegration or absorption of the bones and ligaments of the spine. It is divided into two distinct stages.

During the *first*, inflammatory disease (caries) of the bones of the spine is going on, which leads to softening of these parts, to loss of their shape, very frequently to fusing together of several of the segments of the spine, and to a deformity at the seat of the disease, which is usually angular in character. The first stage of the disease is accompanied by inflammation and attended frequently by the formation of abscesses and other symptoms, which will be presently described. After a certain time and treatment, however, the inflammation subsides, consolidation of the softened bone takes place, and the first stage terminates; but there is left, as the result of it, in the course of the spine a fixed distortion, comprising one or more altered segments, and the rigid consolidated mass so composed is inharmonious with the true undulatory working of the rest of the spine, and provokes a continuation of changes in the spine itself, which are restituent.

It is the *second* stage that comprises the progress of these restituent changes, and as the results of these, if not guarded against, are frequently of great gravity, it becomes necessary to treat the second stage mechanically and with the same care as the first. This point has not before been drawn attention to, and will be more fully gone into later on.

Osseo-ligamentous curvature does not follow a regular and set course in the same way as musculo-nervous curvature does, nor is the length of its duration at all definite. Frequently a few months will comprise all its changes; on the other hand, the inflammatory stage may continue with unclosed chronic abscesses for years. Its origin is usually attributed to a blow or jolt, still there seems no evidence to show why it should not spontaneously originate in people of certain constitutions; at the same time the statement of its invariable connection with a strumous or rheumatic constitution is not generally accepted as absolute.

(*a*) **First stage of osseo-ligamentous Curvature** is preluded by general malaise. Pain is experienced in the course of the spinal column, at times distinctly referable to a particular spot, at others, vaguely diffused over a greater area, which becomes over-sensitive to touch and temperature. A palpable point of weakness and tenderness becomes apparent in certain segments of the column, at which the least jolt or jar of the body is productive of great pain, and on which consequently every effort is made by the sufferer to throw as little strain as possible. From this arises a constrained gait, while a strong disinclination to stoop or in any way shake the body is evinced, all the natural pliancy of the figure being usurped by a self-imposed stiffness. Opposite the weak point referred to an eminence or irregularity in the evenness of the spine usually arises, and gradually increases till there is formed an angular prominence, more or less large, at which the spine has often the obvious appearance of having given sharply way. Over this prominence the tissues often have an inflammatory look and are very sensitive to the touch.

These changes, which are apparent externally, are but indications of what is really taking place out of view. The disintegrating disease attacks the substance of the segments of the spine, rendering them soft and depriving them of that firmness on which their maintenance of shape depends. The segments, unable to sustain the weight which they ordinarily bear, yield under compression, and are forced out of position in the manner recognised on the surface as angular, and to a degree in accordance with the ravages of the morbid processes. The spinal mechanism is, of course, put out of gear, while the spine itself becomes practically divided into two strong healthy parts meeting at a weak, diseased, inflamed, and painful point. Now, the efforts nature makes to remedy the evil consists,

first, in striving to clear up by suppuration the *débris* made by the disintegrating disease, and when this *débris* is collected as pus, to get rid of it either by absorption or by discharge; and next to attempt to hold the spine as motionless as possible while new bone is laid down to repair the breach made by the erosive disease, an attempt which gives that rigidity of appearance to the back which is so characteristic of this malady, and which has been aptly described as the patient's forming for himself a "muscular splint." These efforts of nature, although utterly inadequate in action, are perfectly correct in intention, and the treatment of this stage of the curvature, therefore, will consist in carrying out by art the plan indicated by nature, but which she herself is incompetent to fulfil.

Treatment.—First, by proper constitutional and medicinal treatment the health of the patient must be brought to such a condition as to enable the system to get the better of the degenerative disease, while the removal of all suppurative *débris*, either by absorption or through carefully opened abscesses, is encouraged. This purely medical portion of the treatment does not fall within the pale of these pages, and indeed it has been fully dealt with in other works by more qualified pens.

The other portion of the treatment is, however, entirely mechanical, and has for its object to hold the diseased part of the spine quiescent and motionless, to relieve it from the grating and grinding of the burden which in health it is well able to bear, but which when broken down by disease it cannot tolerate.

The appliance to do this must be a *passive* one, there being no call for active power. Its duty is not to cause permanent changes (as an active appliance does), but, on the contrary, to check the least temporary ones. It must also hold as great a length of the spine as possible, because it would be

insufficient to only actually grasp the diseased part, for the movements of the spine are undulatory, and pass along it as waves flicked along a loose rope, so that if only the diseased part were held, the waves of motion would still progress along the unheld parts of the spine and be stopped with a jolt at the held part, and their power be distributed as a vibratory jar over such held and diseased part, an occurrence quite at variance with real repose. The appliance must also as far as possible remove the weight of the superimposed structures from the diseased part, for rest demands not only absence of movement, but absence of pressure. Lastly, the appliance must carry out the above points without interfering with the vital functions of the body, such as respiration or digestion, and it must not prevent the patient taking that great accessory to health, exercise. Although the spine must rest, the patient must still be able to walk and take air if necessary.

A splint, as previously stated, is the most passive of all passive appliances, and it is by a splint therefore that the aims just enumerated must be carried out, and that this first stage of osseo-ligamentous curvature must be treated.*

The form of splint best suited for the purpose is portrayed in the ensuing figure. It is composite

* Considerable attention has within the last few years been drawn to spinal splints, and more especially to the plaster-of-Paris splint applied on the suspensory system introduced by Professor Sayre. The author believes he will be able to show the reasons why the plaster splint is not the best form of spinal splint, but that, on the contrary, the one he is about to describe has many advantages over it. It may be here parenthetically observed that a splint *of any kind* can only be useful for this particular stage of this particular kind of curvature, and that it may be accepted as a general statement that in all other stages and kinds of curvature a passive appliance like a splint is not at all indicated, but that, on the contrary, appliances exercising actual active power are requisite, and that consequently what is held by Professor Sayre and conveyed in his work on the subject, that the plaster splint applied according to his suspensory method is the best application for all kinds of curvature is fallacious. As, however, the suspensory-plaster system will have a chapter devoted to its consideration later on, discussion on these points will be withheld till then.

in structure, being firm and rigid over the parts of the body which must be kept absolutely at rest, and soft and elastic over those parts of the body which move with respiration and digestion. The *firm*, rigid part is composed of leather accurately fitted (in a manner that will be presently described) so as to embrace completely the back and sides of the body. Leather is used for the purpose on account of the accuracy with which it can be moulded, the firmness combined with lightness that it affords, and because it is not harsh, is porous, and produces no deleterious influence on the body, a point proved by the perpetual use of leather in boots. The *elastic* parts of the splint is composed of an elastic webbing laced down the middle line of the thorax and abdomen. Its elasticity allows the natural movements of the chest during respiration, the increase in the size of the abdomen during meals, and at the same time holds the leathern portion of the splint in *constant intimate relation* to the back, so that there is no space whatever at any point between the splint and the body, and the back of the body cannot drop forwards away from the back of the splint, and so leave the spine unsupported. It might be thought that the elastic power necessary to hold the body in the splint would be sufficient to seriously incommode the act of breathing; this, however, is not so, nor can it be so when it is considered that a person can breathe easily while lying prone on the floor on his chest, in which case much greater pressure is exerted on the front of the chest than is required to be exerted by the elastic lacing to keep the splint firmly in its place.

The upper edge of the splint reaches as high as the level of the armpits, beneath which it is rounded so as not to cut the folds of the armpits themselves, and yet at the same time to be high enough to allow these folds to cling easily over it. Sometimes arm-pieces are added, similar to those shown in Fig. 14, to

support the arms at the armpits, and placed in such a way as to be able to be moved up and down so as to afford greater or less fixity to the arms. The upper border of the splint is carried to as high a level over the back as the necessities of the case demand. The splint shown in Fig. 21 is high enough if the spine is attacked in the lumbar or dorsal region. If, however, the cervical region or the uppermost dorsal region is attacked, then a prolongation of the splint upwards has to be made to envelope the neck and the back of the head.

The lower edge of the splint may reach as low as is possibly compatible with the patient's ease in sitting down, in which position the thighs are brought at right angles to the body; and while it must not cut the thighs in front when the patient is seated, it may descend well over the buttocks behind.

Such, then, is the general shape and construction of the splint, and it will not only keep the spine quiescent and intimately supported without interference with the vital functions of respiration and digestion, but will also transfer the weight of the upper part of the body direct to the hips, and so save the spine from the labour of bearing it, and consequently relieve the diseased point from superincumbent pressure. For the general shape of the body is like an hour-glass, broad at the shoulders and broad at the hips, but narrow at the waist, towards which the upper and lower swells of the body taper. When then the body is encased in the splint, the upper swell of the body will repose in and have its weight borne by the upper bell of the splint, while the lower bell of the splint rests securely

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FIG. 20 exhibits a characteristic case of angular curvature in which the patient, unable through the pain it causes to let the weight of the trunk be borne by the spine, uses the arms to transfer a portion of the weight directly to the legs.

FIG. 21 exhibits the same figure with the leathern and elastic splint on, standing uprightly, the necessity for using the arms being now removed.

FIG. 20. Fig. 21.

on the swell of the hips, and thus transfers the weight borne in the upper bell of the splint direct to the hips.

Method of construction of the splint. The next points to be considered are how the splint can be constructed to fit the body with absolute accuracy and what position the body should be placed in while the splint is being fitted. The method of accurately making the splint is as follows:—The patient is placed in the correct position after his back has been bared, and a speedy primary mould of the back and sides of his body is taken, either by plaster of Paris or gutta percha, after which he is dismissed for the two or three days during which the splint is being constructed. From the mould so obtained an inverse cast is made of plaster, and this acts as the block on which the leather for the splint is fitted while moist and limp, after which the said leather is hardened and dried. The leathern replica of the primary mould thus obtained will fit the back with the same precision with which the primary mould did, and it is completed by covering and lining with thin, soft leather, and by the addition of elastic front lacing, so as to form the entire spinal splint.

The process presents no difficulties whatever, the patient having the primary mould taken in a few minutes and the splint being made in a couple of days, when it is laced on the body and only removed for the purposes of washing, or of dressing abscesses if such exist. The splint so constructed does, and always has for many years since done, its duty properly, provided that in the case of growing children it is periodically reblocked to conform to the exigences of growth.

The position in which the patient is placed during the taking of the primary mould has to be decided with due regard to the diseased condition of the spine. If the spine is neither very weak nor very painful, then the patient may simply stand as up-

rightly as possible, the heels being placed together in order to ensure the pelvis being level, and the hands resting on the top rails of the backs of two chairs placed one on each side of him to ensure steadiness during the taking of the primary mould. If, on the contrary, the back is very weak and the spine is diseased to such a degree as to cause standing to be accompanied with much muscular effort or pain, then the patient is placed prone on a level sofa, care being taken to put the body straight and the hips and shoulders true; the primary mould is then easily taken in this recumbent position. Quite young children can be placed prone on the lap of the mother or the nurse, as they remain quieter in this way.

Now, it will be observed that in the disposition of the body by the above plans, no attempt is made by traction or otherwise to reduce the deformity. Whatever changes of form have taken place they are viewed as unalterable at this stage. What is wanted is absolute rest, an end not gained by active interference. The aim of the splint is to prevent all movements and undulations of the spine, and to relieve the diseased spot from the onus of bearing superincumbent weight. Having removed pressure from the painful point it would be rashness, even if it were possible, to substitute constant traction in its place. Such a course would be to escape one extreme and to rush into an opposite. It is the mean between pressure and traction that is required, the mean of passive rest, and this is what the splint constructed in the manner above detailed best gives. When healing of the sore spot in the spine is complete, when consolidation of the softened bone has taken place, then only may one look for change of form for the better, and it is this change of form which forms the subject of the second stage of osseo-ligamentous curvature, and will be presently described.

Two other points must be noticed before dismissing the subject. No splint alone can overcome or remedy the tendency which strongly exists, of some sufferers under osseo-ligamentous disease, to lean persistently to one side or the other. When such an inclination is the case, accessory holds have to be taken on the legs to obtain a check to the evil, and the leathern splint readily admits of their attachment.

The second point is this:—Although a splint offers the greatest possible breadth of hold, and secures the amplest immunity from motion, still there are cases in which there is no real necessity for such completeness, and where a light passive steel appliance, comprising the rudimentary essentials of the splint, is all that is needed.

(*b*) **Second stage of osseo-ligamentous Curvature.**—It was usually imagined that osseo-ligamentous curvature (Pott's, or angular curvature) was "cured" when consolidation of the previously diseased bone had taken place, and it had never been pointed out till now that another stage really followed, which might be just as critical and require nearly, if not quite, as much care as the former one did. The fact is, that after consolidation the spine is medically sound, but mechanically injured. The actual disease no longer exists, and the tissues have become healthy and natural, but since certain vertebræ have given way and become misshaped a new element of unnatural form has been introduced into the course of the spine, which is out of harmony with the working of the spine, and which provokes in consequence further *restituent* changes, whose course constitutes the second stage of osseo-ligamentous curvature.

The ensuing figures will perhaps explain this more clearly. They show side by side the figures of the vertebræ in the same portion of the spine, in the one case (Fig. 22) before the attack of the disease, in the other case (Fig. 23) after the disease

has run its course and consolidation taken place. The vertebra between the lines *a b* in the one figure is perfectly sound, while in the other figure the remnants of the same vertebra are shown between the lines *c d*. To these remnants, whether they consist of one previously diseased vertebra, or of two, or more, the term "consolidated mass" may be applied for convenience, and it will be observed by comparing the lines *a b* and *c d*, that the upper and lower surfaces of this "consolidated mass" are vastly altered in plane from the position they can be seen to have held in the healthy spine prior to the attack; and it will be consequently clear that there is in the course of the spine a new element, the consolidated mass (composed of one, two, or more vertebræ) whose planes of articulation with the rest of the spine are entirely at variance with the original construction of the vertebral segments.

It would of course be possible for the disease (caries) to attack a vertebra and to be carefully treated while incipient, so as to pass away without deforming that vertebra at all and without altering the planes of any of the vertebral segments of the spine. This might sometimes though rarely happen, and then there would be no deformity, and the case would never pass into the second stage at all. Still, in nearly all cases there is deformity, and there is a "consolidated mass" left with false planes of articulation, and this provokes, as will instantly be shown, further general changes in the spine which are restituent, and which if ungoverned and uncared for may progress to such a degree as not only to greatly deform the body, but to seriously impair, by the changes of the body's shape, the nervous, abdominal, and thoracic organs.

For Restituence was explained to express that muscular obedience to the gravital law in virtue of which the parts of the body tend to assume and maintain a certain form in accordance with the truth

or the reverse of their surroundings. It was shown with respect to the spine that if its base below be true, its burden be true, and its bony segments be true and unchanged by disease, then the healthy muscular system in obedience to the gravital law tended to constantly maintain the whole body true and undeformed in a series of set curves, as portrayed in Fig. 3. But if through accident or disease any change of truth arose (either extrinsically by changes in the truth of the base or burden of the spine, or intrinsically in the spine itself by changes in the form and truth of its bony segments), then under this provocation and in obedience to the gravital law, the body tended to assume a new restituent form and set of curves which, being a departure from the natural, were recognised as deformity. The body may not always assume this unnatural form very rapidly, but it constantly tends to and will gradually and finally do so, unless the restituent tendency be governed, or the provocation be, if possible, removed.

Now, it has just been shown how by disease a "consolidated mass" is formed in the course of the spine, and how the planes by which this mass articulates with the rest of the spine are unnatural, it will therefore follow by restituence, that the spine will tend to take an unnatural form or deformity in proportion as the false planes of the "consolidated mass" differ from the true plane of the vertebra from which it originated. But as the disease or

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FIG. 22 is a representation of five dorsal vertebræ, the middle one of which has the planes of its surfaces indicated by the lines *a b*.

FIG. 23 represents the same vertebræ, the middle one having been subjected to caries, and the new planes of its surfaces are indicated by the lines *c d*. It is to this alteration of the planes from their true direction that the second or restituent stage of osseoligamentous curvature is due. This figure, which is mathematically true, is interesting as showing the relationship of the previously carious spot to the prominences of the spinous processes as felt on the surface of the back, the most prominent spinous process being above the diseased spot.

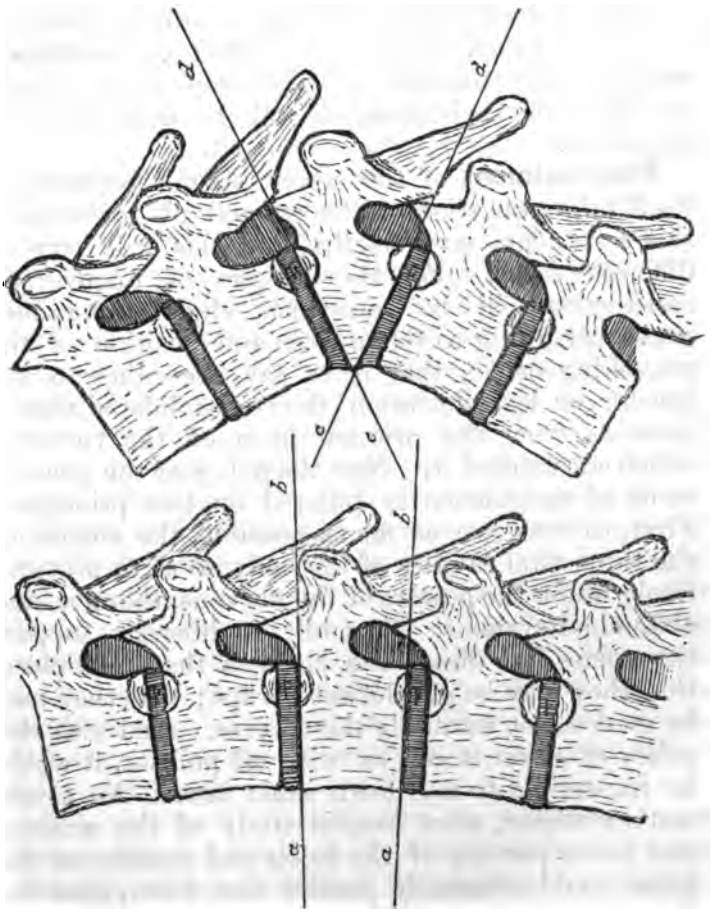

FIG. 23.

FIG. 22.

caries is comparatively quick in its action, and as the restituent changes are in comparison slow, so it usually happens that the disease is finished before the results of restituence are fairly advanced; and consequently it is found, when the actual disease is cured and the first stage ended, that another problem has to be faced, namely, what effect the restituent changes will produce if permitted to continue, and whether such changes will be deleterious or otherwise.

The treatment of the second stage then resolves itself into a question of the amount of government this restituence may require, and this will vary in different cases. For the dangers of ungoverned restituence will be sometimes slight, sometimes grave, according to the degree and position of the provoking cause, that is to say, according to the greater or less deviation the "consolidated mass" presents from the original form of the vertebræ which constituted it. Now the policy of the government of restituence is pillared on two principles. First, to conserve, as far as possible, the shapes of the three vital cavities of the body, so as to preserve freely intact the powers of the nervous, thoracic, and abdominal systems. Secondly, to liberally support the spine and direct the changes that take place, that they may be gentle, not abrupt; that they may be guided, not wantonly the reverse. And with this policy of government, as with all policies, it would be impossible to lay down exact laws. An astute mathematician, after careful study of the motions and motor powers of the facets and muscles of the spine, could accurately predict that when, after the first stage of osseo-ligamentous disease, certain alterations of planes of the facets have ensued, then such and such restituent changes would infallibly occur, and such and such forces be requisite for right control. But the intimate mathematics of the spine are very complicated, and further, these

changes of plane cannot be gauged with accuracy in the living body, hence the rougher results of experience in many cases have to act as the guide, in lieu of the inapplicable refinements of the laws of science. But the whole treatment, whatever its keynote may be, must harmonise with the two principles aforesaid.

The appliance, then, for osseo-ligamentous curvature in the second stage has, as its primary object, to govern restituence on the principles above laid down, and to preserve the body from any rapid or injurious changes that might result if proper precautions were not taken; but it has in addition other objects. It has, as it were, to take charge of the body after the splint which was previously worn has ceased to be requisite. In the first stage the object of the passive splint was to remove to the fullest extent all weight from the diseased part of the spine, and to check as far as possible all its movements. In this second stage, however, the disease has been cured and no longer exists, and the necessity for *passive* rest is therefore gone, while the spine is again able to bear weight as it was wont to do, and must be gradually permitted to take its natural burden. Hence, while on the one hand the body has still to be kept under control (and that of an *active* kind, a point which constitutes a clear distinction between this and the previous stage), there is nevertheless not any necessity for the complete restraint which was before imposed upon it.

The amount of control, and the length of time during which control is necessary, vary with the strength of the patient and the amount of restituent provocation that exists (which restituent provocation, it will be borne in mind, is due to the amount of deviation the "consolidated mass" presents from the original form of the vertebræ which constitute it). If the restituent provocation is slight, and the form which the spine tends to take does not differ

very much from the natural form, then the appliance for this second stage need only be regarded as a temporary one, taking charge of the spine for a brief period, only, indeed, until the spine is fit to take charge of itself. But if, on the contrary, the restituent provocation is great, and the form the body tends to assume is widely divergent from the natural form, then it is obvious that the body must not be allowed to follow its tendencies, and the appliance must be constantly worn to counteract restituence, so that the body may be conserved as nearly as possible to the natural shape, and not undergo a disturbance which, if it were permitted, would not only greatly deform, but greatly impair the health of the patient, by injuring the vital organs through compression and dislocation.

The appliance has the construction depicted in the adjoining Figs. 24 and 26, and it will be observed that, as in some of the appliances previously described, so in this there is the same arrangement of of *base-band* and *lateral uprights*. The base-band encircles the hips, and is retained in its place by a gussetted webbing accurately fitting the swell of the hips. From the sides of the base-band spring the lateral uprights, which are made with a slide in their course, by which means they can be shortened or lengthened at will; they terminate above at the armpits in arm-pieces or crutches, and in these the arms repose. By this arrangement of base-band and lateral uprights, it is obvious that the weight of the trunk can be borne on the crutches, and so transferred direct through the uprights to the hips, instead of being transmitted along the spine itself, and the spine can thus be relieved of weight to a degree that can be governed at will, for if the crutches are heightened, they will bear more weight, and if lowered, less. It has been objected, by an opponent of this plan (Professor Sayre), that taking the weight off the spine by these means is

"simply absurd," and taxes the "endurance of the patient." That this objection itself is simply absurd will be apparent to any one who considers that when invalids are walking on crutches, as they frequently are for months, the *entire* weight of the body is taken at each step by the crutches without any inconvenience at all to the patient, and that therefore to take only a portion of the weight of the body (probably much less than half) by means of the crutches of the uprights, will be attended by less inconvenience still. This arrangement of base-band and lateral uprights can be made comfortably to bear as much or as little of the burden of the spine as is desired, and so to relieve the spine itself to the extent which may be necessary. It can also regulate the relative level of the shoulders in some degree, so that a shoulder that is too low can be raised somewhat by raising the crutch, and *vice versâ*, one that is too high can be allowed to fall into the lowered crutch.

The active agent is the part of the appliance specially dedicated to governing the spine directly. The base-band and uprights are only intended to relieve and buoy the spine, in order that the active agent may act with greater facility. The active agent, shown in Fig. 24, is one very widely used, and it consists, as may be seen, of two spring-metal bands which pass up the back from the base-band, overlying the muscles which cover the transverse processes of the spine. These two spring bands are connected above by light wires with the tops of the lateral uprights, and these are, when so arranged, consequently fixed at either end. Throughout their course the spring bands are fitted and moulded flatly and evenly to the body, and can be so tempered and set that while still closely fitting the form, they exercise, at any desirable place, any desirable pressure or control. It will be seen that these spring bands, rising as they do from the back

of the base-band, rise practically from the back of the bony pelvis, for the base-band and pelvis are practically one. The spine and the spring bands, rising in intimate relation from the same base as a common footing, have secured to them also a community of action, becoming, as far as possible, united in movements, so that the spine moves under the control of the spring bands and with them, while they retain, at the proper points and parts, a constant influence over it.

With respect to the *amount of control* exercised by these spring bands on the spine, it is easy for them to be made of any stoutness or thinness of metal, and of any firmness or pliancy of spring. If the bands were made absolutely rigid and devoid of spring, they would constitute only a passive governor of the spine, and an appliance of the form of Fig. 24 with such an arrangement would be a nearly passive appliance and most nearly what a splint is, only less diffused in its hold on the body; such an appliance is the first step, as it were, in the transition from the passive splint of the first stage towards the active appliances which govern restituence in the second stage. As the spring bands, however, are given spring temper, and as the spring power is rendered lighter and lighter, so the transitions are easier, from the early times of the second stage (when the body has just been taken out of charge of the splint) down to the later times when the necessity for governing the spine may be decreasing, so that the spine, at first under absolute control, may pass gradually to partial control, and finally to

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FIG. 24 represents an appliance for the restituent stage of osseo-ligamentous curvature. Fig. 15 is a similar appliance.

FIG. 25 represents a case in which the bony disease has ceased and consolidation taken place, and in which, nevertheless, treatment has to be continued, and probably permanently, this case being a most severe one.

FIG. 26 represents another form of appliance for the second or restituent stage of osseo-ligamentous curvature.

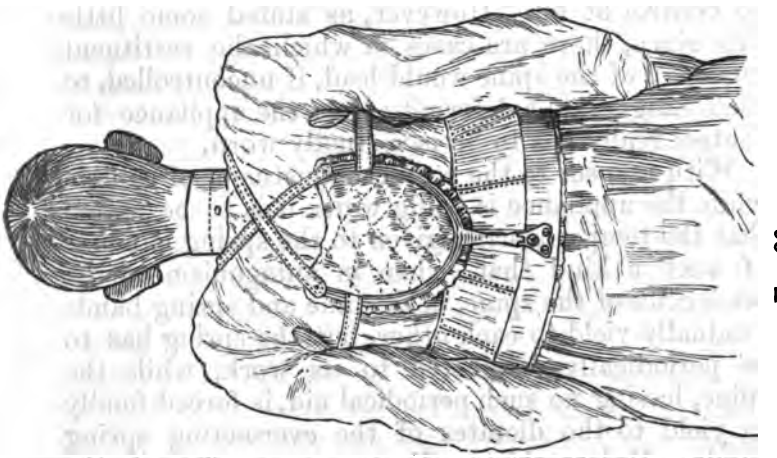

FIG. 26.

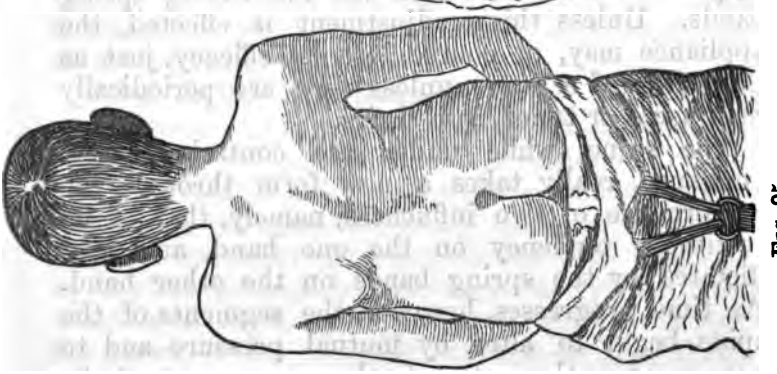

FIG. 25.

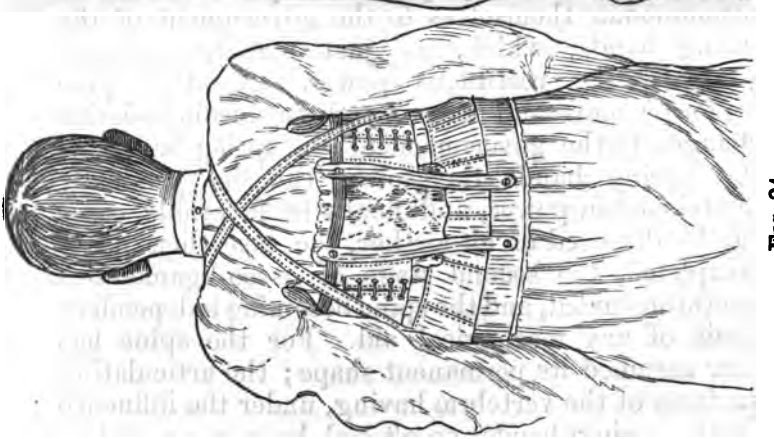

FIG. 24.

no control at all. However, as stated some little time since, there are cases in which the restituent tendency of the spine would lead, if uncontrolled, to such exaggerated deformity that the appliance for control really has to be perpetually worn.

With respect to the correct adjustment of control while the appliance is being worn, it is to be stated that the temper usually given to the spring bands is of such a kind that, when in antagonism to the tendencies of the spine, both spine and spring bands gradually yield to each other, but the spring has to be periodically readjusted to its work, while the spine, having no such periodical aid, is forced finally to yield to the dictates of the ever-acting spring bands. Unless this readjustment is effected, the appliance may, of course, lose its efficacy, just as the wires of a piano, unless they are periodically readjusted or tuned, lose theirs.

The spine, while under the control of this appliance, really takes a new form through the compromise of two influences, namely, that of its restituent tendency on the one hand, and that dictated by the spring bands on the other hand. As time progresses, however, the segments of the spine begin to alter by mutual pressure and to accommodate themselves to the government of the spring bands, which, as just stated, overcome gradually the restituent power. As the spine conforms more and more by these accommodative changes to the government of the spring bands, so the spring bands themselves can be gradually diminished in power, and finally in favorable cases can be disposed of altogether, the case then being completed, the second stage of osseo-ligamentous curvature ended, and the spine becoming independent again of any mechanical aid. For the spine has now assumed its permanent shape; the articulating surfaces of the vertebræ having, under the influence of the spring bands, so altered by accommodative

absorption, that as the result of this alteration restituence now dictates maintenance, and no longer alteration of shape.

It sometimes happens that the spine after finally assuming its permanent form still displays a weakness in doing its duties; then the buoying of its burden is continued by means of crutched uprights of the lightest kind, as shown in Fig. 14, which are fastened to ordinary stays and which are made secure at their lower end by bridging the hips, instead of arising from any base-band, as in the previous appliance. This aid forms the ultimate step in the transition from the splinted acme of restraint on the one hand to absolute freedom on the other, a transition which in most cases is perfectly and rationally indicated.

Other forms of appliances.—Now, although a large number of cases may pass by transitions safely through the stages of osseo-ligamentous curvature till cured and till independent of mechanical support, there are, nevertheless, many cases in which the original deformity produced in the first stage has by neglect perhaps become such that it becomes a mechanical necessity to stay and support the spine for years, if not for ever; that is to say, that it becomes impossible to bring the segments ever to alter sufficiently by accommodative absorption as to give the spine a form which would be secure without extraneous mechanical government. And it ordinarily happens that in such cases the spine, in place of requiring a general and diffused support (of the kind given by the spring bands in the appliance Fig 24), has rather need for firm and even pressure in some particular part of its course only, while the rest of the spine can safely be left free to make restituent and accommodative alterations around the part which is so held fixed. Fig. 26 portrays an appliance for this purpose, and it consists of the combination of base-band and lateral uprights

that has been previously described, to which is added an agent suited to give strong and fixed support to a comparatively small portion of the spine.

Cervical Curvature of osseo-ligamentous origin. In the preceding descriptions of curvature of the osseo-ligamentous type, the appliances which are used for the treatment of the dorsal and lumbar portions of the spine have been detailed; at the same time the principles of treatment of the curvature have been elucidated. The same principles precisely have to be observed when the disease attacks the neck. In the first stage passive rest of the spine has to be attained, although in doing this it is sometimes permissible to allow rotation of the cranium at the atlo-axoid joint.

In the more serious cases it is better perhaps to have the head and neck held in a splint constructed to give absolute immobility of the parts.

In less serious cases the weight of the head alone need be borne by being slung in straps passing under the chin and occiput, and by these straps being fastened to a head gear, which in its turn is attached either to a leathern splint or to a passive frame appliance embracing the body. By this means the weight of the head is transferred to the pelvis, and it is at the same time so fixed that the cervical spine is prevented from any movement of moment.

The second or restituent stage in the neck is never as serious as when the disease has been lower down, because there is during the progress of the disease in the first stage much less superincumbent weight to be borne at the diseased spot, and consequently much less liability to change of form by compression of the softened bone. As a rule, therefore, gradually permitting the cervical spine to take up its duties, by loosening the restraint to which the head has been subjected, will suffice for the treatment of the second stage, there being usually but slight provocation to much restituent change. Sometimes, how-

ever, this is not so, and then a collaret will have to be worn for some time after consolidation has taken place.

SECTION II.—Extrinsic Curvature.

Curvature of intrinsic origin, as just reviewed, has been seen to originate from direct disturbance of the spinal machine, either involving its musculo-nervous functions or its osseo-ligamentous structures, and to be wholly independent of other bodily disturbances. Curvature of extrinsic origin, on the contrary, presupposes a completely healthy and orderly state of the spinal mechanism, and may be regarded as arising from an accident entirely external to the spine, such accident disturbing either the symmetry of position of the arches which bear the spine below, or the symmetry of mass of the parts born by the spine above, and initiating the restituent assumption by the spine of novel directions in accordance with these changes.

In short, extrinsic curvature is provoked by some disturbance of the base or of the burden of the spine, and not of the spine itself.

Causes of extrinsic Curvature.—1*st. By disturbance of the* **Base** *of the spine.*—The sacrum or lowermost segment of the spine (disregarding the coccyx, which has no mechanical meaning) forms the keystone of the pelvic arch, of which the legs constitute the piers. The sacrum is, however, part and parcel of the pelvis as a whole, and consequently the pelvis, as a whole, may be considered the base on which the spine is balanced. Therefore any cause that deranges the true level of the pelvis violates the truth of the base of the spine and inevitably causes curvature of a restituent character (in a manner similar to which the "consolidated mass" in the second stage of osseo-ligamentous curvature

provokes restituent changes). For, the moment the pelvis changes in level, the direction in which the spine rises from it is altered, and the whole body above the pelvis is tilted into an unnatural direction, while the centre of gravity of the body is thrown into a false position with respect to the legs. The spine immediately commences to attempt to bring the centre of gravity of the body into a truer position, and in order to do this, it becomes curved, and the body in consequence deformed. This can be easily shown in the perfect body by causing it to stand on both legs with the one leg raised by a block. The pelvis is tilted up on the side of the block, as shown in Fig. 27, and the spine curves to bring the centre of gravity of the body into a stable position. The figure displays a temporary condition arising from the temporary use of the block, but this temporary condition would become permanent if the condition represented by the block were permanent, for the spine having this deformed position dictated to it by restituence would soon, by accommodative changes in its segments, stamp the deformity as a perpetual one.

If the pelvis is tilted antero-posteriorly, then the restituent curve will be antero-posterior, a common instance of this being the increase of the antero-posterior curve in the loins which accompanies hip disease, the pelvis in such cases being tilted forwards by contraction at the hip joint (Fig. 28). When the alteration in the level of the pelvis is lateral, then the restituent curves with be lateral, and a common instance of this kind of extrinsically produced curvature will be those cases of arrested development of one limb in which the shortened limb has not been brought to a proper length by wearing a thickened boot.

FIG. 27 shows the restituent lateral curve instantly formed by causing the natural body to stand on an uneven surface, a block having been placed beneath one foot. The curve in the spine thus formed is due to an extrinsic cause.

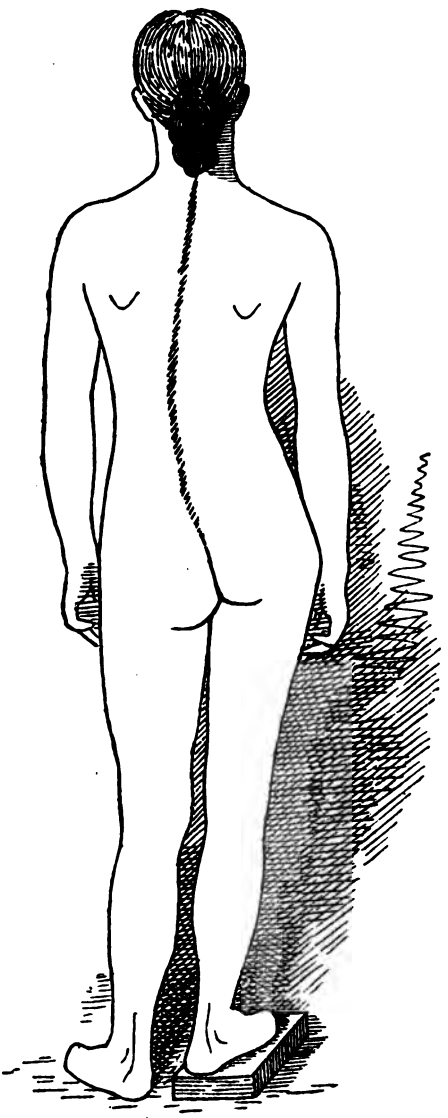

FIG. 27.

The ways however, in which the pelvis may be altered in level are very numerous. The pelvis itself may change in shape, as in rickets or osteo-malacia, the hip-joints may become untrue through disease, dislocation, or fracture. One leg may become shorter than the other through arrested development, contractions of the knee and ankle-joints, clubfoot, rickety curving; and in whatever direction these causes tilt the pelvis, in a similar direction will the restituent curvature establish itself.

2*nd. By disturbance of the* **Burden** *of the spine.*— Alterations in the symmetry of the burden borne by the spine are simple and few, being comprised chiefly in differences that may arise between the weight of the arms, owing to one of them having been abortive, withered, or amputated, or in serious displacement of the head, as in wryneck.

Treatment resolves itself into two things: first, the removal of the extrinsic irregularity (of base or burden) which is provoking curvature, and next the elimination by proper instrumental treatment of such spinal curves as may have arisen before the case was properly looked after.

For example, if one of the lower limbs becomes by arrested development two inches shorter than the other, then the pelvis will be tilted down on the side of the shortened limb two inches every time a step is taken in walking. If no progressive treatment has been adopted, that is to say, if no high boot has been worn on the shorter leg to make the length equal to that of the longer one, then there will have been in standing and walking a constant tilting of the pelvis to one side, and as a restituent result of

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FIG. 28 is designed to show the antero-posterior curve in the loins produced by the antero-posterior tilt given to the pelvis through contraction and anchylosis of the hip-joint. In such a case the lumbar vertebræ acquire an increased range of motion to make up for the immobility of the hip-joint.

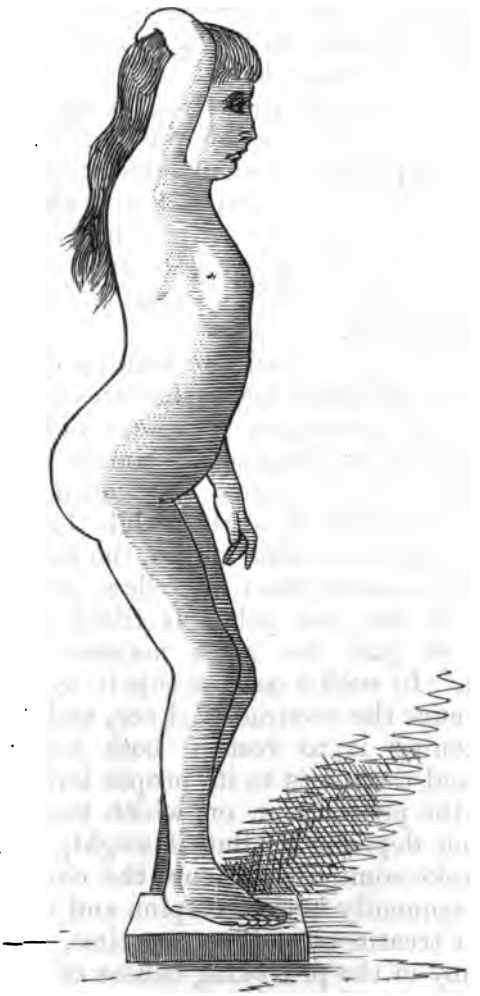

FIG. 28.

this, a double lateral curve will have arisen in the course of the spine, provoked entirely by the tilting aforesaid. The treatment then will obviously consist, first, of giving to the shortened leg a boot with a raised sole of sufficient height to make the shorter leg of precisely the same length as the longer, so that in standing or walking the pelvis (or base of the spine) may be level; and next of applying to the body such an *active* apparatus as shall eliminate the curves that have arisen under the provocation of the tilted pelvis. And so it is in all cases of extrinsic curvature that may arise; the first point is to remove the provoking cause if possible, and the next is to eliminate the curves provoked.

In the case just cited the removal of the provoking cause was simple and instantaneous; sometimes, however, the provoking cause can only be removed by a definite or lengthened course of mechanical treatment. For instance one knee-joint may have gradually contracted, so that while the bones of both legs are *really* the same length, the contracted leg is *practically* shorter than its fellow, and as a consequence of this the pelvis is tilted and the spine curved in just the same manner as previously detailed. In such a case as this it would be necessary to cure the contracted knee, and by gradually straightening it to restore both legs to an even length and the pelvis to its proper level, and thus to remove the provocation on which the curvature of the spine depended. But it might, and probably would, take some time to cure the contracted knee, and consequently both the spine and the leg would be under treatment at the same time. And so it is with many of the provoking causes of extrinsic curvature; they have to be removed gradually and by proper treatment conducted at the same time that the spine itself is subject to the active influence of such appliances as may eliminate the curve already formed.

Now, as the provoking causes of extrinsic curvature are from their very nature deformities and abnormalities of some part of the body other than the spine itself, so the treatment and cure of these provoking causes will not fall within the province of a work which is dedicated solely to deformities of the spine, and it is sufficient here to insist on the fact that the treatment of extrinsic curvature must include the treatment of some other part of the body in addition to that of the spine itself.

The appliances by which the curves of the spine itself have to be eliminated are very various, but the same principles which have been elucidated in describing previous appliances, underlie the construction of those for extrinsic curvature. The burden of the spine has to be buoyed, and such *active* force exercised as will counteract the alterations in form that may have arisen. A *passive* appliance, such as a splint, is therefore in such cases obviously useless.

SECTION III.—Complicated Curvature

By this term is meant the coexistence of two or more of the different types of curvature previously described. It is quite possible for the spine to become deformed by the simultaneous progress of, for instance, an intrinsic and an extrinsic type of curvature. For example, it frequently happens in growing girls that the atonic state of the system which allows the muscles of the body generally to become relaxed will give rise to general musculo-nervous curvature, as previously described, and at the same time one or both of the feet will become subject to valgus through atonicity of the muscles which support the arches and ankles of the feet. Now, it generally happens in these cases that the valgus is more marked in one foot than in the other,

and that one foot will give way to such an extent as to practically shorten the leg to which it belongs, and allow the pelvis to tilt towards that side in proportion to such shortening. When this occurs the tilting of the pelvis or base of the spine will provoke (as has been detailed) extrinsic curvature, while at the same time musculo-nervous curvature will be progressing; and so it comes that the two types of curvature are coexisting. Following this out still further, it would not be impossible for caries to attack one of the vertebræ, and osseo-ligamentous curvature to ensue, and then the unfortunate patient would be suffering simultaneously from three different types of curvature, namely, musculo-nervous curvature, due to atonicity of the system, extrinsic curvature, due to the tilting of the pelvis which depends on valgus of the foot, and osseo-ligamentous curvature (Pott's), due to the attack of caries. Such a combination of curvatures would justly deserve the title complicated, nor are cases of this kind as uncommon as might be supposed.

Treatment in such cases will rest on a proper recognition, after careful examination of the body, of the types of curvature which are simultaneously progressing, and each will have to be met in the manner that has previously been laid down as necessary. Sometimes it will be quite possible to treat simultaneously the several types which together constitute the complicated curvature; sometimes, on the other hand, this cannot be done. For instance, if there coexisted musculo-nervous (rotato-lateral) curvature, due to muscular atonicity, and extrinsic curvature, due to valgus of one foot, then the valgus would be treated by the proper boot and instrument supporting the ankle and arch of the foot, and restoring the pelvis or base of the spine to its true level, and at the same time the musculo-nervous curvature would be met by the *active* appliance proper for the stage in which it happened

to be, to which active appliance there would also be superadded, if necessary, such an agent as should tend to eliminate that portion of the curvature which was purely provoked by the tilting of the pelvis through valgus. On the other hand, supposing that there coexisted extrinsic curvature due to valgus, musculo-nervous curvature due to atonicity, and osseo-ligamentous curvature arising from caries, then, although the valgus could be treated immediately by the proper boot and instrument, the spine itself could not be at once subjected to any *active* appliance with a view to eliminating the curvature, but would have to be kept in a state of quiescence by a *passive* splint till the caries had passed away and the bony parts had consolidated, after which such an active appliance as may be necessary to tend to restore the spine to its true shape, from which it had been diverted by three different simultaneous causes, could be employed.

Appliances.—As complicated curvature is really the combination of several types of curvature, so the appliances by which it is met must combine, as far as possible, the essential points of those suited for each separate type. It will be unnecessary to describe specially the appliances themselves, as they are subject to much variety, and as the essential principles of their construction have been embodied in previous pages.

SECTION IV.—Infantile Curvature

Spinal curvature not unfrequently affects infants at an extremely early age, and is sometimes even congenital. It may, of course, chance that a child is born altogether malformed and is deficient in bony or structural regularity, parts in the scheme of the bodily design being missing or abortive, as instanced in the case of spina bifida; but setting

such cases as these aside as abnormalities in the orginal plan of construction, it is not uncommon to find quite young children suffering from spinal curvature of the ordinary types which are evident after departures from a plan of construction which was originally perfect and correct.

Now, an infant may be mechanically considered as a child who has not yet learned to walk, or who, in other words, has not yet acquired the art of rearing its spine on the triplet of arches formed by the legs and feet. For an infant has to acquire by degrees the power of assuming the erect position, learning this gradually. At first it is propped in a seated posture on the lap of its mother or nurse, and the spine then commences to assume the function which afterwards becomes so especially its own, namely, that of balancing the body in the erect position by maintaining the just locality of the centre of gravity of the entire body. As yet the true curves of the spine which are so constant and characteristic in the adult are not fully formed, nor are they needed while the child is only becoming used to sitting on the broad basis of its buttocks. And it is while the child is learning to easily adopt this position, and while the spine is, as it were, taking its earliest balancing lessons, that one kind of infantile curvature will sometimes show itself, the spine being inadequate in strength to the work it attempts to do, and becoming deformed in consequence. The bony segments of the spine of an infant are neither fully ossified nor completely formed, and consequently do not constitute the same precise and regular guide to the course of curvature in the infant as they do in the adult; but then for the same reason they offer less opposition to the restoration of the body to its proper form by correctly applied active mechanical force.

Causes and treatment.—The causes of infantile curvature are fewer and simpler than those of a later

age, because many of the provoking causes of adult curvature are the outcome of the erect position assumed in walking, and as the infant has not acquired the power to rear itself on its legs, so these provoking causes are altogether absent. It will be found consequently that infantile curvature may be restricted to an origin from one of two causes, either from disease of the bony structure of the spine or incompetency of its muscular elements.

Bony disease or caries affects infants as it does adults, and requires the same treatment precisely as has been previously described, namely, the passive maintenance of the diseased parts in a condition of rest till the disease be passed, and the subsequent control of the spine by an active appliance if the amount of deformity left by the disease should be sufficient to justify this. This only need be said, that the appliances used for these purposes are necessarily lighter than those needed at a later age.

Infantile curvature of the muscular type may arise from the incompetence of the muscles generally to fulfil the duties laid upon them when the child first begins to sit up, and when the spine commences, as has before been said, its earliest balancing lessons. This incompetence may be shown by an inability of the child to sit erect, and a tendency to become "doubled up" when placed in the seated posture; and next there may arise, unless care be exercised when this is first noticed, lateral curves and such rotation of the ribs as makes the one side of the back appear distinctly larger than the other. The mere muscular weakness of the spine can be met by causing the child to wear a light stiffened stay, and this will generally, after some little time, be able to be dispensed with, because the muscles, which were previously a little backward in the matter of strength, become able, as the child grows, to take up the duties to which they were formerly inadequate. If however, this has not been done in time and curvature

has supervened, then it is necessary to employ active force to restore the body to its proper form. This can be usually simply effected by the insertion into little stays of light strips of whalebone so bent with their convexity to the body that when the stays are laced direct pressure is exercised over the area covered by the whalebone. The reason so simple a plan is generally found to answer is that the bony segments of the spine are still so soft and so unfully ossified that they will readily yield to very light pressure, especially when such pressure tends to direct the body towards the form at which growth is aiming.

Curvature of the muscular type may also be produced by spasmodic action of the muscles, such as arise occasionally from teething, but these causes are rare, and have to be met as necessity arises, hence general rules can barely be laid down for them.

SECTION V.—Secondary Results of Spinal Curvature

There are certain disorders of the vital organs of the body which are found to accompany spinal curvature and which are in their origin purely mechanical. For as the spine, becoming deformed, loses its shape, so do the guardian cases of the vital organs (namely, the nervous-centre case, the thorax, and the abdomen) lose theirs also, and getting altered, cramp, compress, or dislocate the vital organs that are contained within them. Now, the disorders of the said organs, which are the natural consequences of such changes, are, since their origin is mechanical, amenable also to mechanical treatment, that is to say, as the body is restored by mechanical means towards its natural form, so the vital organ cases will resume their natural shape, and the organs themselves which suffered compression or dislocation

will cease to be compressed or dislocated, and will cease also any longer to be disordered. It is these functional disorders to which the term or the secondary results of spinal curvature may be aptly given. At first sight there might appear to be no connection between the spine and the vital organs, and it might be received with incredulity that the wearing of a spinal appliance could restore such an organ as, for example, the uterus, to the healthy tone from which by dislocation it may have lapsed; viewed, however, in the light of the above explanation such can readily be perceived to be the case.

These functional disorders are common to all types of spinal curvature, and arise in a degree which is in accordance with the position and the severity of the spinal deformity they accompany. Their consideration most easily falls into the order of the vital organ cases which contain them.

The nervous-centre case is constituted by the cavities of the skull and spinal column, and these contain respectively the brain and spinal cord, while from the spinal cord emanate the spinal nerves, leaving the spinal canal through the foramina at the junctions of the bony segments of the spine. The brain is as thoroughly protected as a kernel in the shell of a nut; the spinal cord, being comparatively much smaller than the spinal canal, lies loosely within its bony clothing, but the spinal nerves more nearly fill the holes through which they pass. These things being so, it happens when the spine becomes deformed that the brain is by its isolated position absolutely protected from direct ill effects, that the spinal cord is but little liable to harm, except when a spinal curvature arises of so acute and angular a kind as to endanger its actual construction, but that the spinal nerves, on the other hand, are more exposed to injury, and that it does not require any very extraordinary deformity of the spine to render them liable to traction or compression by these

means and to entirely derange their functions. As a consequence the nervous disorders which are the outcome of spinal curvature are found to be as follow. When the actual spinal cord is pressed upon, then there ensues loss of power in all the parts to which nervous communications passing the seat of pressure are (centrifugally) distributed, while both intense pain and reflex actions follow as the result of irritation (centripetally) conveyed to the brain from the injured spot. And what happens with the spinal cord occurs for evident reasons in a less degree when any of the spinal nerves are the subjects of injury; paralysis of the muscles to which they are distributed, pain along the course of their distribution, and reflex phenomena, all may exhibit themselves. This is very marked in strong lateral curvature where the intercostal nerves are interfered with, and intense pain is felt along some of the ribs, a pain, however, readily alleviable by the very mechanical appliances by which the spinal curvature is treated, which curvature is in reality the cause of such pain. And so it is with all the secondary nervous results just enumerated; they for obvious reasons yield rather to mechanical treatment than to anything else.

There is another peculiar nervous state which, although not connected to curvature as a secondary symptom, nevertheless should not be overlooked at this point, being as it is amenable to mechanical cure. Its evidences are known under the name of spinal irritation, and they can be either real or hysteric. If real, there is, without any actual deformity, great tenderness, sensitiveness, and aching of the spine and its immediate surroundings, and these are met by light mechanical support which gives rest to, or rather relieves, the spine, and so gradually puts an end to the irritable condition. If hysteric, there may be presumed to be a mentally produced hyperæsthesia in the immediate region of the spine, an over-sensitiveness which is terminated

by rest as well as by even pressure diffused over the adjoining parts, this being apparently due to the fact that a hyperæsthetic sensibility of such a kind can be obliterated by sending other impressions (of pressure in this case) along neighbouring nerve-ways, just as when a paining part is suddenly dipped into cold water the cutaneous nerves are occupied, and those which previously transmitted the pain fail for the time to have their impressions felt or attended to. Finally, this hysteric spinal sensitiveness may be presumed to be purely imaginary, and in such cases the appliance may act as a mental rather than a bodily cure, faith being pinned to it by the patient who is subsequently cured. Be this as it may, this nervous irritability over the spine is not uncommon.

The thorax contains packed in its cavity with an extreme nicety the heart and lungs, both pumps, the one of fluid, the other of air. The heart, although very intricate in its mechanism, pumps for itself, and is in its work fairly independent of the natural form and action of the chest and ribs, being only perhaps seriously injured when these are much deformed. The lungs, on the other hand, do not pump for themselves, but rely in great part on the action of the ribs for this work, and depend also on the true shape of the chest for their fullest and most perfect form. They discharge, therefore, their duty with full propriety only so long as the natural mobility and form of the ribs are undisturbed; and when, as happens in nearly all cases of spinal curvature, the chest becomes cramped and the ribs distorted, then the aëration of the blood becomes materially diminished and deficient, the constitution anæmic, and the nutrition of the body much impaired. And it by no means requires a very considerable alteration from the natural curves of the spine to produce this result, for it may be seen in the very earliest stages of spinal curvature. For example, general musculo-nervous curvature it will

be remembered arises from a lack of tone in the muscles of the spine, in consequence of which the natural spinal curves begin to show signs of changing, the shoulders are no longer held back by the muscles dedicated to that purpose, and the pectoral muscles no longer have retracted shoulders as their *points d'appui* in respiratory action, besides which the actual muscles of respiration have become so atonic as to fail to do their full amount of respiratory work. Respiration being thus impaired in action, the blood is inadequately aërated, a fact which goes towards still further reducing the tone of the system, and this in its turn again diminishes still further respiratory movements and blood aëration, so that a kind of accumulative lowering of the system is going on. The moment, however, that the appliance depicted at Figs. 4, 5, 6, and 7 is put on, the muscles of the spine are given their deficient power, the true curves of the spine are restored, and the thorax thereby enlarged in capacity, the shoulders are held back and constitute proper points of action for the pectoral muscles, and the tidal amount of air in the respiratory act is increased (as may be tested by a spirometer). As a consequence the blood is more fully aërated, the tone of the system improves, anæmia disappears, and muscular energy becomes increased in such a way that all the train of symptoms (which are really the outcome of loss of muscular tone) disappear also, the muscular mechanisms of the body are restored to perfection, and finally the appliance itself, which wrought the beneficial changes, becomes no longer needed. And if spinal curvature, when even incipient, has so deleterious an effect on respiration, it will be easily understood that when confirmed curvature has arisen, and the actual chest walls have become altered, respiration is affected to a still greater degree. And so it may be laid down that one of the secondary aims of all *active* appli-

ances for spinal curvature is to expand and enlarge the chest for respiratory purposes, while all *passive* appliances (such as splints) must have provisions by which they shall not interfere with the amplitude of respiration.

The abdomen contains a large number of organs slung within it by mesenteries and ligaments with the greatest seeming laxity. This laxity is, however, a matter of appearance only, for in reality the disposition of the abdominal organs is most perfectly ordered, and they are ranged one above the other with a precision on the nicety and aptness of which depends the due discharge of their proper functions. Some are subject to the freest movement, but always within proper and prescribed limits. So long as this ordained tether is not exceeded, great liberties of motion are capable with immunity. On the contrary, when the legal bound is broken, when the spine, the mast to which these said organs are directly or indirectly rigged, so changes that their lines of suspension become lax or misdirected, then they fall into a huddled heap one on the other, and their functions are fouled and interfered with.

Now, as a large portion of the abdominal organs are those dedicated to the function of digestion, it will easily be appreciated how curvature of the spine, by producing the mechanical displacement of the organs in the manner above mentioned, will give rise to a loss of alimentary tone, digestive derangements, and such constitutional disturbances as are dependent on ill or perverted nutrition, and it is not only a fact that such symptoms are accompaniments of spinal curvature, but also that they disappear under the mechanical treatment that is employed to cure the curvature itself; for the influence of the natural curves of the spine in maintaining the natural position of the abdominal organs is by no means hypothetical, and, indeed, it is very prettily proved in certain cases of hernia, where,

when the patient is in such an unbraced and lounging posture that the natural curves of the loins and back are for the moment lost, then the intestine can be coughed through the inguinal canal and shows as a hernial swelling, while the moment the body is braced up into the natural, smart, and erect posture, the intestine is raised by its mesenteric attachment out of the inguinal canal and the hernia disappears.

Of all the abdominal organs, however, the one that is most exposed to the dislocative changes just alluded to is the uterus, and there is probably no organ whose dislocation is attended with graver consequence. From the peculiarities of its position and from the functional changes that it has to undergo, both in form and character, it labours under especial disadvantages. It holds a place below the other abdominal organs, and if, by any circumstance, these latter are caused to drop from their true and natural level, they must of necessity crush down the uterus, which, comprised as it is within the firm bony cup of the pelvis, has no means of escaping such superincumbent pressure. Nor has it even that further element of security the rectum and bladder (which share with it the lowermost position in the abdomen) possess, namely, of intimate attachment to the bony walls of the pelvis; on the contrary, it is merely as it were moored within the pelvic cavity, and is, from this fact, exposed to distortion in almost every direction, for the lines of its mooring are by no means taut. And further, from the very principle of its mooring, it depends very much for its stability in a proper position on the true and natural position of the pelvis itself, or, as it is usually expressed, on the correctness of the "pelvic angle;" and whenever this pelvic angle is altered, and the cup of the pelvis is, as it were, tilted out of its natural level, the moorings of the uterus no longer balance that organ in a just and even

position. Hence it happens that when, even in the early stages of spinal curvature, the lumbar curve is straightened and the pelvis is changed, forming a new angle with respect to the perpendicular, that the uterus is carried into a position which is disadvantageous to its chance of maintaining its shape. At the same time the bowing of the back permits the other organs (especially the intestines) to drop on to the uterus, which by its change is in a position wholly unfortified against the aggression; and further, when the constitution is atonic, the actual tissues are ill-disposed to resist interference. As a consequence the uterus and its adjuncts give way, become malposed or misplaced, pain and functional disturbance ensuing. There is a sense of dragging in the small of the back, and frequently pains of a bearing-down character in the abdomen.

Now this state is often a concomitant of spinal curvature. It also is common with women who, having no actual disposition to curvature, are nevertheless through weakness or fatigue prone to sit not erectly but with the lumbar curve straightened, and in short to assume a position very analogous to that of the first stage of musculo-nervous curvature. And it is by a modification of the very appliance designed for this first stage that such cases are met and ameliorated, the appliance doing two things, namely, reconstituting the lumbar curve and supporting the abdominal walls. The effect of its action is this: the pelvis, and with it the uterus, is restored to its natural angle or plane, and the back ceasing to be bowed, the organs which are swung by ligaments over the pelvis are pulled by the tightening of these said ligaments, as the body is erected, away from all chance of interference with the uterus, which, restored to its power of keeping a position necessary for the healthy discharge of its functions, takes at once advantage of the opportunity to resume its natural position and tone.

CHAPTER III

ON THE SUSPENSORY-PLASTER TREATMENT

In the two preceding chapters the author has carefully endeavoured to show, first, the principles on which the origination of spinal curvature rests, and next the various and widely different kinds of spinal curvature that can exist. He has detailed the several broad and distinct types of spinal curvature, and has also shown the manner in which some of these types are themselves made up of stages quite diverse in the manner in which they arise, and in the method by which they have to be treated (*vide* Programme, p. 32). He has further exhibited the lines of treatment indicated for each different type and stage of spinal curvature, proving thereby that it is impossible for any single form of mechanical appliance to be an absolute panacea for every type and stage of curvature.

Now, this the author has done with the express intention of combating the affirmation that has practically been made within the last few years by that distinguished orthopædic authority, Professor Sayre, of America, that a plaster splint applied according to his method actually is such a panacea. This gentleman, whose widespread reputation probably ranks him as one of the highest orthopædic authorities in the world, thus expresses himself in the preface to the latest work in which his views are elucidated :—"As having such full faith in the plan of treatment he has of late devised and carried out that he is anxious to see its adoption to the exclusion of all others in this (England) and in all

other countries." The author of the present work will endeavour to conclusively show that the plaster splint which Professor Sayre believes serviceable for all kinds of curvature, has been proved, both on practical and theoretical grounds, only suited to one particular stage of one particular kind of curvature (namely to the first stage of osseo-ligamentous curvature, or in other words, to the acute inflammatory stage of Pott's curvature), and not to any other kind of case. And further, he will endeavour to explain that while the plaster splint *per se* may be a suitable and economical treatment for the particular stage of the particular kind of curvature just mentioned, that even then there is not the slightest necessity to apply it according to the suspensory plan so insisted on by Professor Sayre; and, lastly, that even for this particular stage of curvature the composite leathern-and-elastic splint (described p. 73) is more fully capable of perfectly carrying out the principles of treatment indicated than is the plaster splint.

And the author would not venture to express haphazard an opinion contrary to the teaching of so distinguished an authority as Professor Sayre if he had not had the amplest opportunity of testing the methods that have been described in the previous parts of this work, and of comparing them side by side with those advocated by the professor, and if also he had not used his most careful efforts to become perfectly acquainted with all the details of the suspensory-plaster application to a degree far more studied than its simplicity and ease were stated by its talented originator to demand. He had the fortune to hear and witness Professor Sayre's able demonstration on the procedure of applying the plaster jacket, and immediately subsequently he was enabled, in conjunction with his brother (at that time house-surgeon at the Middlesex Hospital), to make the experiment of practically

putting the plaster jackets on some hospital patients. This done, he had a room expressly fitted up in his own house with every proper apparatus for the application of the plaster jackets, of which he personally applied a very large number, many at the request of some of the leading surgeons in London. It was after gathering experience of them in this manner, that he chanced to attend Professor Sayre's second demonstration at University College Hospital, and struck by the severe and somewhat sarcastic strictures the professor passed on every other treatment except his own, he determined to make every endeavour to show what were the fallacies of the suspensory-plaster treatment, and by explaining the different kinds and stages of spinal curvature to demonstrate how impossible it was for the passive plaster splint to be universally suitable for any and every kind of curvature that might arise.

And in order to do this the author will review, first, the details of the suspensory-plaster application as they are directed to be put into practice by Professor Sayre himself; next the practical results which the suspensory-plaster method met with at the hands of the British medical profession; then the theoretical considerations which bear upon the suspensory-plaster treatment, and which both anticipated and confirmed all the practical results; and, lastly, he will draw a comparison between the merits of the plaster and of the leathern-and-elastic splints in those particular cases in which a splint is indicated as necessary.

The practical details of the Suspensory-plaster application.—The plan of constructing the plaster jacket was laid down as follows:—The body of the patient, having been previously stripped, was clothed with a tightly fitting woven jersey, between which and the skin were placed, over the regions of the chest and stomach, a series of pads, whose objects were to enlarge *pro tempore* the corpulence of the jersey.

Having been so clad, his arms and chin and skull were received into proper loops, by whose means the entire body "was gradually drawn up until the feet swung just clear of the floor," and until of course the spine was in a state of greater or less tension in proportion as the body was hanging more or less wholly by the head and arms, this being also the precise proportion in which the spine suffered the traction occasioned by the weight of the lower part of the body. While thus suspended, bandages soaked with moist plaster of Paris were lightly wound round the person and over the jersey, till a layer of the requisite thickness was obtained. The jacket so constituted was allowed to set hard. The patient was then lowered and freed from the suspending gear, the pads, previously interposed between the jersey and the skin, were removed in order that respiratory and digestive hollows might intervene between the patient's body and the plaster jacket in the region of thorax and abdomen, after which the jacket was smoothed and trimmed along its edges from irregularities which might chafe the body of the wearer, who was subsequently dismissed to carry this irremovable case-hardening for weeks or months till the next application was deemed necessary.

This was, in brief, the actual appliance that Professor Sayre advocated as the universal remedy for spinal curvature, "to the exclusion of all other methods," only he varied the plan by which suspension of the patient was carried out in accordance with the differences of the kinds of spinal curvature he believed to exist. He stated in his published works on the subject that there were but two kinds of deformity of the spine, "the one known by the name of Pott's disease" (Author's osseo-ligamentous curvature) and the other "known as rotary lateral curvature of the spine" (Author's musculo-nervous curvature), at the same time he failed to recognise

any various stages as existing in these kinds of deformity and requiring various treatment; on the contrary, he believed that all spinal curvature was remediable by an identical method of treatment, namely, by his suspensory-plaster method. And the only necessity for any variation that he recognised was the difference in the plan of suspension just alluded to; in Pott's disease he directed that the patient, slung by the head and arms, should be raised by the operator or his assistant; while in rotary lateral curvature the patient was slung by the head alone, and raised himself by drawing on the cord of the suspensory gear with his disengaged arms. In each of these cases suspension was stated to produce an alteration in the shape of the spine, which alteration the plaster jacket was imagined to maintain.

Such being, then, the method and idea of the suspensory-plaster treatment, it will be well next to review the train of practical evidences by which its efficacy as a universal treatment for spinal curvature was first impugned, and finally disproved altogether.

Practical evidence against the Suspensory-plaster treatment.—The actual application of the splint took from ten to twenty minutes, during the whole of which time the subject of the operation, suspended in mid air by the head and arms, was in an extremely unpleasant and trying condition. By the constriction of the suspensory gear the circulation in the arms became impeded, and they passed through the disagreeable sensation known as "pins and needles," and subsequently becoming blue and cold lost feeling altogether. At the same time the muscles of the entire body, braced and knit at first into an involuntary effort to control the discomforts of suspension, became after a minute or two fatigued and powerless, while the patient relapsed into a state of pendant and distressing helplessness.

Retching and vomiting not unfrequently supervened; the patient sometimes fainted before the completion of the splint, and there are on record one or more instances in which fatal results have followed. It was evident then that to submit even a strong and healthy person to such an ordeal was by no means a thing to be lightly done, while, with much greater reason, it was obviously questionable how far it was wise to cause a nervous, impressionable, or delicate invalid, already weakened by the advances of spinal disease, to undergo such an operation.

These points were clearly apparent; still, as the suspension was absolutely insisted on by Professor Sayre as an essential principle of his novel method, some modifications of the suspensory gear were attempted whose aim was to alleviate the more trying conditions of the process. Inventions were introduced which, by systems of pulleys or otherwise, allowed a discriminating allotment of the shares of the body's weight borne by the head and arms respectively to be made; more weight could be thrown on the arms and less on the head, and efforts were made by these means to still carry out the principle of suspension with less risk and discomfort to the patient. Even with these improvements, however, suspension was still found to be too trying to admit of general use, and gradually the way was experimentally felt towards submitting the body to less and less suspension. At first the toes were allowed just to touch the ground, next they were permitted so to rest on the floor that a good portion of the body's weight was borne by the legs, and finally, it was definitely established, as the result of trial, that in the particular kinds of cases in which the plaster splint could really be said to be of service, quite as good results were attained by allowing the patient merely to stand ordinarily upright, and if the suspensory gear was used at all,

merely employing it to steady the body in this position. And ultimately, as a proof that suspension was wholly unnecessary, it was shown that, where the feeble condition of the patient required it, the splint was equally efficient if applied even in the recumbent position (by the hammock or any other method).

While practical experiment was thus gradually but surely subverting the much vaunted principle of suspension, efforts were also being made to invent some other plastic material of which the splint could be made, to supersede plaster of Paris, and so obviate the hardness, heaviness, and other discomforts which the plaster possessed. This is merely mentioned in passing to show that while the principle of its application was found to be unsound, the splint itself was also considered sufficiently unpleasant to warrant attempts being made to obtain some more wearable material for its construction.

The most important result, however, of the lengthened and patient trial the plaster-suspensory method had in this country, was the discovery that (notwithstanding what had been urged by its distinguished originator) in whatever manner the splint might be applied, it was useless in all except one particular kind of cases, namely, in cases of Pott's disease. And that it should be serviceable even in such cases would have been by no means a novelty (for a splint, no matter how made, either of gutta percha or leather, had always been recognised in this country as the appropriate treatment for the acute period of Pott's disease) unless it had been stated by Professor Sayre that by means of the suspensory-plaster plan an amelioration of the angular curve could be gained; and to show this he advised that by means of a flexible strip of lead the accurate contour of the spinal deformity should be taken in the first instance and traced on paper as a

record, and that subsequent tracings, taken in a similar manner after the suspensory treatment had been adopted, would show the improvement that had taken place in the curve. In his published work on the subject he had figured a number of such comparative tracings, demonstrating the manner in which the spinal curve in Pott's disease had been improved by the suspensory-plaster treatment. But here again Professor Sayre's views were found to be distinctly at variance with the facts of the case as they were afterwards experimentally proved to stand. It was sufficiently obvious that danger might attend any attempt to straighten the softened and diseased parts of the spine by traction, but it remained for carefully conducted experiment to conclusively show and prove that, even if traction were exerted as advocated under the plaster-suspensory method, no straightening of the spine ever could be produced; and thus again on this point also the principles of the new treatment fell through.

To sum up then. Professor Sayre introduced the plaster-suspensory method to supersede all other plans in the treatment of curvature of the spine, and its principle was to submit the spine to traction by suspension of the patient, and to encase the body when so suspended in a rigid splint of plaster of Paris. This treatment had for several years a most careful and universal trial, and the experimental results so attained were that the suspension was utterly unproductive of beneficial effects; that the splint treatment, no matter how applied, was only serviceable in one particular kind of curvature, viz. in the active period of Pott's disease; and that, even in these cases, no straightening of the spine was ever produced. And thus, when Professor Sayre's method was divested by experiment of all that was peculiar to it, when all that was novel in it had been shown to be fallacious, there remained

simply the idea of applying a splint of a harsh, heavy, but economical material, to those very cases which had always been recognised in England as requiring the passive rest given by a splint of some description. And the evidence on which the above statement of facts is established, the proof on which it rests, and the authority of those who elucidated it, are probably of a more weighty and conclusive kind than were ever before brought to bear on any debated point in the history of surgery, as will be now seen.

Professor Sayre introduced his suspensory-plaster method into England under the fairest auspices. The distinguished reputation he enjoyed, the professional esteem in which his name was held, gained for it a more speedy hearing than is usually accorded to what is esteemed to be a great scientific discovery. He met with every cordiality of reception, the amplest opportunities were afforded him of lecturing on his plans in the principal hospitals in England, and he gave personal demonstrations of his practical procedure so widely, and with such colloquial ability, that it can barely be rash to assert that within a few months after he had come over here there could barely be a town in the kingdom in which his method was not fully known, and where it had not commenced to undergo the test of experimental use, a point which clearly conduced to its having the fullest and most universal trial, as well as such an immediate one as to make it soon apparent that it would not require very long to decide on the merits or demerits of his plans. At the same time (1877) he published his book on the subject, and this he dedicated to the British physicians and surgeons. Now, when the dedication was penned, it might barely perhaps have seemed probable that the British physicians and surgeons who were thus collectively addressed would have the opportunity of as collectively and publicly expressing to Professor

Sayre the result with which the use of the suspensory-plaster system had been attended in their hands. Such, nevertheless, turned out to be the case.

In the summer of 1881 the International Medical Congress met in London, and at it were gathered together representative medical men from all parts of England, and from many parts of the world. Such an assemblage can only be regarded as a medical parliament, and just as the parliament of a nation is representative of its collective people, and the debates and decisions that take place in it are taken as the collective voice of that people, so the debates and decisions of the International Medical Congress in London must be viewed as the authoritative out-speaking of the collective medical men of England, if not of the entire world. It was in such an assemblage as this that Professor Sayre's suspensory-plaster system fell under discussion.

In one of the Sections, under the title of "The Treatment of Spinal Curvature, with special reference to Sayre's Method," a special debate took place, at which were present most of those English medical men who are pre-eminent in orthopædic science, as well also as many distinguished foreigners, among whom figured Professor Sayre himself. This debate terminated on August 4th, and without going at length into the numerous papers that were read (reports of which can be found in the medical journals of the time), it will suffice to say that Mr Holmes, of London, summed up the entire debate with that clear, logical acumen and scientific discernment for which he is so justly distinguished. And it was this summing up, which may, as has just been pointed out, be taken as the collective voice of the medical profession—it was this summing up, which struck at once to the root of the matter and tore away for ever all the peculiar principles which enveloped in novelty the suspensory-plaster system, and left as the sole residue the bare idea of con-

structing a splint in those cases in which a splint had always been recognised as necessary, of such a material as plaster of Paris, a material which, with all its drawbacks (to be presently pointed out), had the advantage of economy only. That this was so will be readily appreciated by examining the principal heads in Mr Holmes's summing up, who pointed out:

1. That it would have been wiser to have limited the discussion altogether to angular curvature, as indeed most of those who had taken part in the discussion had done.

2. That no form of extension (by suspension or otherwise) was a necessary part of the treatment, and that the plaster jacket could be applied whether the patient was suspended, erect, or horizontal.

3. That there was no evidence that any straightening of the spine had ever been produced by the suspensory plaster method.

4. That though Dr Sayre appeared to prefer the plaster, there seemed no valid reason why any other plastic material would not do as well.

These decrees, and from the manner in which they emanated they may justly be called so, are to be taken as final; the more so as they were not the critical and biassed statement of any inveterate opponent of Professor Sayre's system, but were, on the contrary, the impartial expression of the pith and drift of a carefully conducted debate, in which advocacy of all the tenable points of the system had not been wanting, and in which, further, all the personal talent and ability of language which Professor Sayre himself possesses had been brought into play. And when these decrees are made sequential, and the proper preamble is put to them, the following statement, the facts of which are incontestable, is arrived at.

The suspensory-plaster system was introduced by Professor Sayre with the avowed object of treating

all kinds of spinal curvature, and its principles were the attainment of a certain improved position of the body by means of suspension, and the permanent maintenance of this improvement by a plaster-of-Paris splint. This system of treatment has had a careful, universal, and practical trial, extending over at least four years (1877 to 1881), and the medical profession, speaking collectively through the International Medical Congress and by the mouth of Mr Holmes, have found that the suspensory-plaster system is of no use in any except one kind of curvature (angular curvature or Pott's disease); and that even in these cases it is only the splint *per se* that is of benefit, suspension having nothing whatever to do with its efficacy, and being therefore, apart from its inconveniences and its dangers, absolutely unnecessary; while the material of which the splint is composed is a matter of indifference, any mouldable material answering the purpose if sufficiently stiff; and that consequently the only novelty in the new method is Professor Sayre's preference for plaster-of-Paris as the substance of the splint for that particular set of cases which had always been recognised in England as requiring splint or passive treatment.

Theoretical evidences against the Suspensory-plaster treatment.—And the very same conclusions which have just been drawn and proved as the result of practical experiment can also be arrived at on theoretical grounds alone. Further, at the outset, when the suspensory-plaster method was first introduced by Professor Sayre, there could be no difficulty (as the Author showed in a published work) in predicting precisely similar results to those which were experimentally found to hold good.

For if the programme at page 32 be looked over, it will be found that of all the various types and stages of curvature there enumerated, there is one kind only indicated as requiring a *passive* appliance

for its treatment, and that kind is the progressive stage of Pott's disease prior to consolidation (first stage of osseo-ligamentous curvature). In the chapter which follows the programme the reasons of this are very carefully gone into and proved, and since the plaster splint, no matter how applied, whether under suspension or otherwise, is nothing but a *passive* appliance, it follows that it cannot be of any service in any cases requiring activity of treatment, that is, that it can only be of use in the one particular kind of curvature just mentioned.

That the plaster splint never is and never can be other than a passive appliance is easily proved. For if it is applied in the ordinary erect, or in the recumbent position, and without any attempt at traction on the spine by suspension, it is obvious that it is merely a pure passive splint, not tending as such to alter the shape of the body in any way, but merely maintaining the position of the body with an efficiency dependent on the accuracy with which it can be moulded to fit the form (an accuracy which is none of the greatest, as will presently be shown, in consequence of the inelastic circuit of the splint, and the necessity for leaving loose spaces for thoracic and abdominal movements). But if, on the other hand, the plaster splint is applied on the suspensory method, it must be done on the presumptions, first, that suspension actively causes the body to assume an improved position, and next that the plaster splint, applied during such suspension, will maintain the improvement suspension is supposed to originate. And both these presumptions are utterly fallacious. *Suspension in such cases does not produce an improved position* of the body. For the spine is a column whose vertebral segments, one above the other, have their contingent surfaces in constant apposition, and move under the guidance of these apposed surfaces. As such a column the spine is used in every-day life, and as such a column

it lapses into a deformity known as curvature, and the deformity can only be removed by treating the spine as a column, or, in other words, by leaving the opposing facets and surfaces of the vertebral segments in apposition, and making them the guide to restoration of form, just as they have been the guide to loss of form. Traction by suspension does not tend to restore the spine to its natural shape, for traction separates the facets and treats the spine as a chain, not as a column. And Dr Judson's very instructive contrivance for showing the formation and elimination of rotato-lateral curves of the spine, which is quoted by Professor Sayre in support of his views, is, singularly enough, the very contrivance which disproves his views; for it is a *sine quâ non* in the action of that contrivance that the spine acts as a column, and that its segments are in natural apposition, and not separated by traction. Suspension, therefore, will not restore the deformed spine to its natural shape. And even if it were granted, only for argument's sake, that suspension would ameliorate the position of the spine and body, the suspensory-plaster system would still fail, for the *plaster splint cannot maintain nor perpetuate any improvement* that might be imagined to take place. For when the body is suspended by the head and arms the shoulder-blades rise several inches from their natural position. When now the plaster splint has been put on and become hard, the patient is lowered, and the pads, previously interposed between the splint and the body over the front of the thorax and abdomen, are taken away, and by their removal leave a great loose space in front of the splint. At the same time, suspension being over, the shoulder-blades descend, and wedging themselves between the back of the splint and the back of the body, thrust the body forwards and immediately deprives its back of the intimate support the splint is supposed to give. The body in fact comes to rest loosely in

the splint, and all possibility of maintaining the effects of suspension is at an end. This fact can easily be shown by percussing the splint, when it will be found that there is not the intimacy of contact that has been asserted; and further, this point is corroborated by the fact that if the splint be evenly sawn down the front, and the patient be removed from it, he can easily be replaced without any suspension at all, the splint closing with accuracy along the line of section. It is obvious that if the splint only fitted and maintained the position produced by suspension, then suspension would be needed to restore the patient accurately to the splint, and such is not the case. Therefore the splint cannot and does not keep up a state of things which suspension was supposed to originate.

Hence it has been shown on theoretical grounds that the entire suspensory-plaster method is fallacious, and that the splint *per se* applied without suspension is of service only in one particular kind of curvature; this being precisely the same conclusion which was shown to be the result of practical experiment.

Comparison between the Plaster and Leathern-and-elastic Splints.—Now, while it is admitted that the plaster splint applied without suspension is, on economical grounds, a very useful splint for cases in the first stage of osseo-ligamentous or Pott's curvature, and for such cases only, it will be shown that it does not carry out the treatment indicated with the same perfection as the leathern-and-elastic splint does, which was described at p. 73 of this work. It was there pointed out that in these cases there is required the most perfect rest of the spine from flexion, undulation, or jar, and that this perfection of rest is given by a splint fitting the body with the greatest possible accuracy, and allowing at the same time freedom for the movements of the thorax and abdomen in respiration and digestion. But it has

also been shown that the provisions made for respiratory and digestive movements in the case of the plaster splint are effected by interposing pads between it and the body during its application, and by removing these pads when the splint is hard, so as to leave large loose spaces in front of the splint over the region of the chest and abdomen. And it is to these loose spaces that the plaster splint owes its lack of perfection, for the body is permitted thereby to fall forwards through the splint, and the back of the patient ceases in consequence to be in apposition with the back of the splint, and hence the body is not held with that firmness and security which an intimate relationship between it and the splint would maintain. But with the leathern-and-elastic splint it is quite different. The elastic front of this splint holds the body firmly in and against the back of the splint, while at the same time it fully admits of the movements of respiration and digestion, and the consequence is that the splint is always in intimate apposition with the back of the patient, and the spine is held with greater firmness and security than by any other plan. Hence, in point of *efficiency* the leathern-and-elastic splint has immense advantages over the plaster one.

But there are other advantages that the leathern-and-elastic splint enjoys beyond the paramount one of efficiency. With regard to *cleanliness;* according to Professor Sayre's teaching the plaster splint is irremovable, and has to be continuously worn from the time it is applied until the period at which either through breakage or looseness a new one is deemed necessary. The fatty and acrid perspirations of the skin accumulate, and a state of uncleanness arises which is at first disagreeable and finally disgusting, while the skin itself, clogged with its own secretions, loses its functional power, and by its inactivity reacts deleteriously on the health of an already delicate patient. The leathern-and-

elastic splint, on the other hand, can be removed easily and without risk by unlacing it from the patient while recumbent, and the cleanliness and healthy functional activity of the skin can be maintained by ablution.

Then, again, in consequence of the permanent fixture of the plaster splint the parts it covers are subject to a constrained *concealment*, and so all irritations, excoriations, or abscesses that may arise are perforce hidden from view and inaccessible to treatment, so that the surface of the skin covered by the jacket, in addition to having to go unwashed, has also to go unwatched.

Next, with respect to *weight;* the plaster splint if made sufficiently strong to resist breakage is extremely heavy, while if of a thinness and lightness consistent with the delicate state of the patient, it is fragile and subject to speedy fracture. The leathern-and-elastic splint is not open to these objections.

Again, on the head of *substance;* the plaster splint is very harsh, and if it be made to come into anything like forcible supporting contact with the body, it is certain to cause abrasion of the skin, an abrasion the extent of which must necessarily be unperceived, because of the irremovability of the splint. The plaster is really as hard as mortar, being, indeed, a kind of mortar, and the discomfort of mortar in forcible contact with the skin is easily estimable. The leathern-and-elastic splint presents internally a smooth surface, and lined as it is with wash leather, is comparatively soft to the touch though firm to strain, and the skin is by no means intolerant of it, even when in firm and intimate contact with it.

With respect, again, to the *process of construction;* the time required for the making of the gutta-percha mould from which the leathern-and-elastic splint is made is only about a minute, during which period it is not difficult to keep even children at rest. The time,

on the other hand, during which the plaster splint is being applied and during which the patient must remain quiescent until the plaster has assumed such hardness as to be immovable, is about a quarter of an hour, the difficulties of keeping children quiet for so long is obvious. Then, again, if the plaster splint is spoilt by movement it has either to be cut off or unrolled and the process commenced *de novo;* while should the gutta-percha mould be in any way wrong, half a minute's immersion in the warm water will render it ready for fresh application.

Lastly, with the gutta-percha there is no mess whatever, and the same cannot be said of the plaster.

In contradistinction to all these disadvantages under which the plaster splint labours as compared with the leathern-and-elastic one, there are two very great points which it possesses in its favour, which are a great boon to the poorer classes when suffering, as they largely do, from osseo-ligamentous disease; and these points are the *economy* of the plaster splint, and the *facilities* with which the materials necessary for its construction are obtainable almost anywhere. The actual cost of the materials of the splint is covered by a very few shillings, and the importance of this to large charitable institutions dealing with the poorer classes is too obvious to need comment. Further (notwithstanding Professor Sayre's objections to the contrary, which were based on the principle of suspension, and which have been shown to be erroneous), as the plaster splint can be made removable without in any way impairing its purpose, by being sawn evenly down the middle line in front, and then fixing the cut edges by bandage or lacing, the drawbacks of uncleanliness and concealment which were pointed out to arise from the permanent fixture of the splint can of course be obviated. So that while it is maintained that the plaster splint is not the best form of splint when a splint is required,

still it is admitted that it is by no means an inefficient one, and that though it has drawbacks, and these great ones, still for the poorer classes it is an important thing that some form of splint can be constructed so economically as to be within their means or within those of the charitable institution on which they depend. In private practice the question of the economy of the plaster splint barely enters, for the professional time and trouble involved in its application renders its cost quite equal to that of the leathern-and-elastic splint.

There is a final point in the comparison between the two kinds of splint to which attention must be drawn, and that is, that the leathern-and-elastic has been well known in England for years, and always used by competent authorities for the acute stage of Pott's disease; and this fact has been scrupulously unnoticed by Professor Sayre in his work on the subject, and not only has it been unnoticed but a misconception nurtured by him when he says, with almost legal ambiguity, under the head of "Treatment of Pott's Disease:" — "The chief way in which most patients have hitherto been kept straight was by means of some mechanical apparatus pressing directly upon the sides of the projecting spinous processes, forcing them inwards, and at the same time making traction in the opposite direction at other points for the purpose of rendering the spinal column straight." Whatever may have been the case elsewhere, it certainly was not so in England, where the leathern splint treatment has long been recognised as proper in cases of acute Pott's disease. Hence there is nothing new in the simple splint treatment; all that there is new is the use of plaster instead of leather as the material of the splint, and it has just been shown with what advantages and with what disadvantages.

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